Australian Educational Computing

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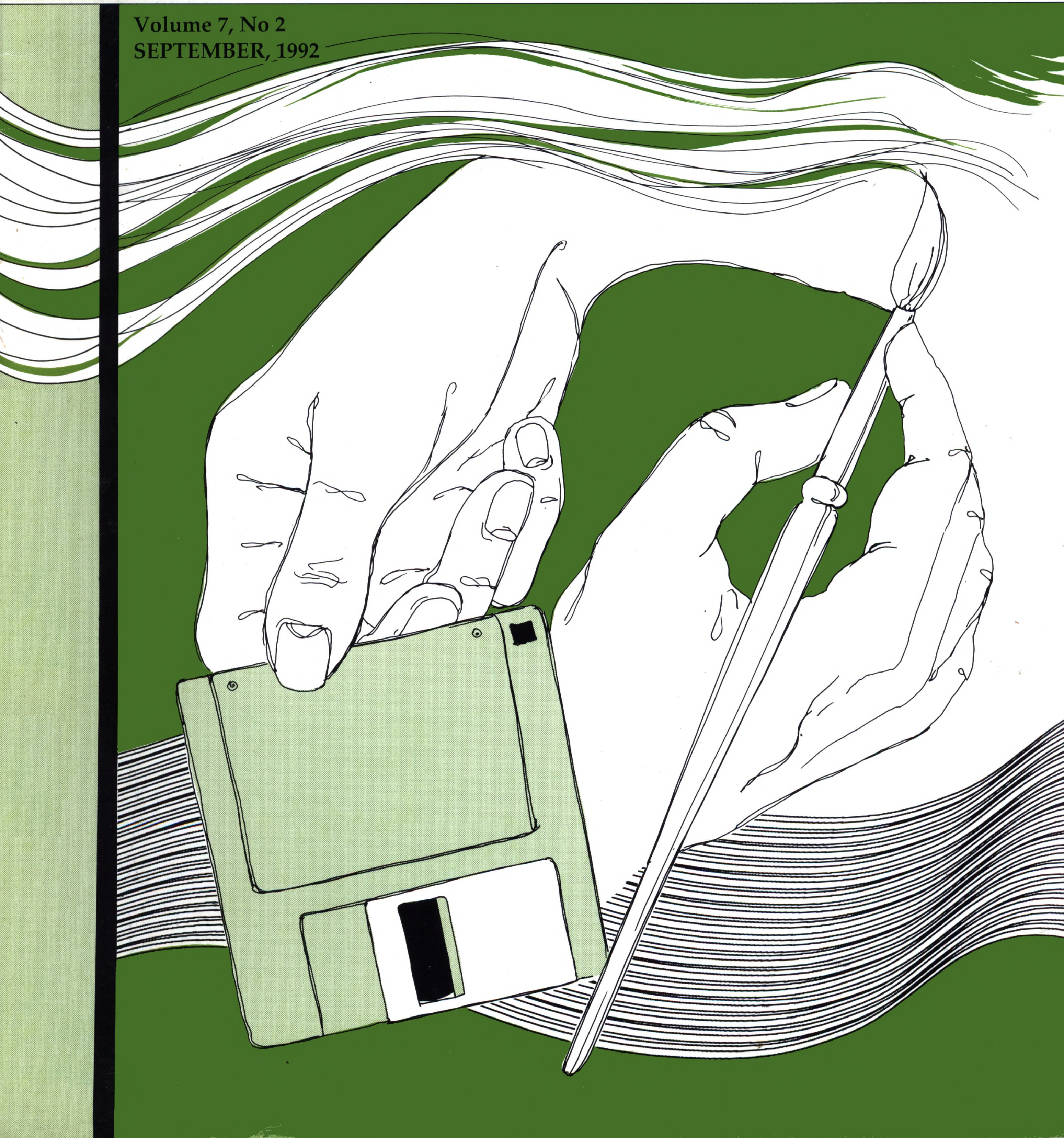

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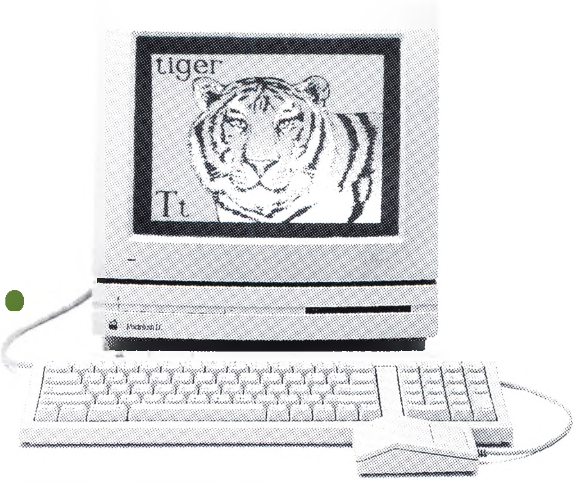

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Volume 7, No 2 September, 1992

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Call for articles
Readers are invited to contribute articles for future editions of this journal.

Articles should be no longer that 4000 words and include an abstract of 100–150 words. Contributors are asked to provide a brief autobiographical statement.
Deadlines: Friday 12 March for May 1993 and Friday 16 July for September 1993
Have your say.
Why not share your interest and concerns about educational computing by writing a letter to the editor of *Australian Educational Computing.*

Address all correspondence to:
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The editors welcome contributions in the form of articles, letters, reports and reviews. Authors should ensure that their manuscripts conform to the Harvard bibliographic convention. All manuscripts should be typewritten, double-spaced on one side only of numbered pages. Figures, tables and graphics should be provided in camera ready form. Photographs should be black and white rather than coloured. Authors should limit articles to a maximum of 4000 words including an abstract of 100–150 words.

Authors are asked to include a brief autobiographical statement and a passport size photograph. All material in the publication is copyright unless otherwise stated in writing and may not be reproduced in any form without the permission of the authors. Permission will normally be granted where material is to be used for non-profit educational purposes.

Refereed Section Authors who wish their articles to appear in the refereed section of the journal, should provide three copies of the manuscript at least two weeks prior to the deadline for an edition.

Opinions expressed by contributors do not necessarily represent the views of the editors or the Australian Council for Computers in Education. The Australian Council for Computers in Education does not endorse products or services advertised in Australian Educational Computing.

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Linda Vogler

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Editorial

The theme of this issue is *Computers and the Right Brain* and contributors have taken a variety of approaches to this topic. The *From the Classroom* section has a strong emphasis on graphic and design applications. Carolyn Dowling provides an excellent overview of the theme with Janni Nielsen and Andrew Gray exploring visual thinking and multimedia.

Two articles were accepted for the refereed section of the journal — 'Devising the device: microcomputer input decisions for young children' by Dr John King and Dr Nola Alloway; and 'The left-handed computer — alternative images of classroom computing' by Carolyn Dowling.

This issue represents the last hurrah of the 1991–92 editorial team. We wish the RITE group every success as they take on responsibility for producing the journal in 1993.

MESSAGE FROM INCOMING EDITORIAL TEAM

In 1993 *Australian Educational Computing* will become a refereed journal. Along with this change, ACCE has given responsibility for managing the journal to a new team — the RITE Group (Research into Information Technology Education) based at QUT in Brisbane. As manager of this group, I would like to take this opportunity to outline some of the developments and consequences that follow from this journal's new status.

The development of a fully professional journal for ACCE has been an evolutionary one. Over the years, there has been significant improvement in terms of style and content — for which the contributors and ACCE members should be proud. The move to a refereed publication will continue this process without dramatic transformation. While readers can expect articles to conform to an academic style, my group is determined to retain a focus that is both relevant to classrooms and practical in nature. A number of initiatives, outlined below, will address the need to retain this emphasis but also encourage practitioners to contribute.

Writers who contribute papers will notice some changes. Each paper will be anonymously reviewed by two referees who will advise the acceptance, acceptance (subject to modification) or rejection of the paper. Rather than being judgemental, this process should be seen as constructive, especially for beginning writers. The editorial panel is committed to the encouragement of writers by providing constructive assistance to complement the referees' advice. The panel of referees has been drawn from Australian and overseas academics who have a special interest in computer education.

In order to encourage contribution, my group has proposed a number of initiatives. Authors (potential and experienced) can obtain a *Writers Pack of Australian Educational Computing* which is being produced by the editorial panel. The pack sets out technical and structural standards for papers, and, over time, will provide advice on the developing editorial policy of the journal.

Although publication itself is a reward for effort, my group believes that there is a place for a further recognition of exemplary papers. In consultation with the member organisations of ACCE, we shall instigate an annual award for the most innovative and outstanding paper published. It is hoped that this initiative will serve to encourage contribution and to enhance the quality of papers presented.

The journal will undergo some structural alterations. Depending on contributions, there should be three sections in each issue:

- Theme Articles — papers which address a specific issue;
- Contributed Articles — papers submitted that have a general appeal; and
- Short Communications — a non-refereed section that might contain letters, brief comments on issues raised in previous issues or pertinent to current debates.

The themes for 1993 have been decided and contributions sought. The first issue will focus on *Computers and Classroom Change.* While some believe that classrooms should respond to technological developments, others believe that opportunities exist to reform classrooms using the new tools that have become available. Still others believe that classrooms will cease to exist in their present form under imperatives generated by technological growth. Whatever the beliefs and predictions, the history of technological innovation in classrooms suggests that there is a reluctance to change — classrooms (in general) function in very much the same way as they have for many years. Why is this? Should classrooms respond or challenge external pressures? What will classrooms look like in the future? These questions are all relevant to the first theme issue in 1993.

The second theme will focus on computer studies — directed at what and how we teach (and our students learn) about computing. Apart from the pedagogy of individual strands within computing and information science curricula, this theme should also encompass developmental issues. What are the key ideas, concerns and concepts, and how can they be developed over the years of formal education — from primary school to tertiary study?

If you would like to contribute to the above themes or to any others in computer education, my group would like to hear from you. We can be contacted directly in the following ways:

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To the Editor........

I refer to your articles on the state of computing education in each state appearing in *Australian Educational Computing*, vol. 5, no. 2, and in particular, to the information provided about South Australia. My particular concerns relate to the adequacy of the information provided regarding senior secondary computing courses.

While the article deals adequately with Stage 1 of Year 11 courses, at Stage 2 of Year 12 level a description is only given of SAS Computing Studies. I find it amazing that SAS Applied Computing, an accredited subject that has been running for four years and is taken by nearly 800 students in South Australia and the Northern Territory, was not mentioned. It should be noted that Business Mathematics and Professional Typing are not related computing subjects but were mentioned in the article.

In addition to this, the Computing Syllabus Advisory Committee of the Senior Secondary Assessment Board of South Australia (SSABSA) have for the past eighteen months been working on the development of a Stage 2 Information Technology syllabus that will replace both the current Computing Studies and Applied Computing syllabuses in 1993 and 1994 respectively. This flexible and forward-looking syllabus is a significant departure from those currently in use in terms of philosophy, structure and content. I was concerned that this dramatic development was not mentioned in the article, as it represents the direction of computing in South Australia for some years to come.

It is hard to believe that Peter was unaware of Applied Computing, or the development of the Information Technology syllabus, as both have been high profile in South Australia. A simple call to SSABSA when researching the article would certainly have provided up-to-date information in both areas.

It should be noted, too, that the article contains several other minor errors about Senior Secondary Computing. While much of the article contains material copied directly from SSABSA documents, it is interspersed with incomplete and inaccurate information, and this portrays a somewhat false picture.

I am concerned that senior computing education in South Australia has not been portrayed properly and that readers of the article will be given a false impression of the current situation and future developments. I hope that this letter will set the record straight and reinforce the need for future articles to be well researched. If the journal does not provide accurate information, its credibility within the profession will be compromised.

Barry Peters
CHIEF MODERATOR
APPLIED COMPUTING
SENIOR SECONDARY ASSESSMENT BOARD
OF SOUTH AUSTRALIA

Australian
Computers in Education Conference 1993

Sharing the Vision

Panthers Convention Centre, Penrith, New South Wales
28 June – 1 July 1993

Over the past years the NSW Computer Education Group has evolved a style of conference suited to the rapidly changing professional development needs of our members. At ACEC '93 this style will be adapted to meet the needs of a wider audience. Conference papers reporting research and scholarship will be presented along side workshops demonstrating successful teaching practice. The conference will provide both horizontal strands at different experience levels and vertical strands in such areas as Cross Cirriculum Computing, Teacher Education, Special Education, Language Education, Science and Technology, Computer Studies and Early Childhood Education.

President's Report

The ACCE held its last Board meeting in July, preceding the national conference in Melbourne. The Board would like to congratulate CEGV for the excellent conference which provided a wide range of sessions from practical classroom teacher presentations to research and theoretical papers.

During the conference ACCE hosted several sessions including a meeting with computer industry representatives. I am pleased to report that this meeting, which was attended by almost all companies represented in the exhibition, was very successful in strengthening the partnership.

The meeting provided the opportunity for industry to express their feelings about their participation in and support of computers in education and their relationships with the various computer education associations. The major topic of discussion was computer education conferences and how they can be best organised to provide for the delegates and for the sponsors. To improve liaison with the industry several initiatives were discussed. It was agreed that better communication and information sharing would assist greatly in allaying many of industries gripes. It is expected that such a forum will continue at future conferences.

Whilst on conferences it is worth reminding members of the forthcoming national conferences. In 1993 the Australian Computers in Education Conference (ACEC) will be hosted by CEGNSW. The venue chosen is the Panthers Convention Centre at Penrith in western Sydney. The dates are from July 4 to 7. In conjunction with this ACCE has written to the Minister for Education, Employment and Training to declare July as Information Technology in Education Month. To date no reply has been received. Should the month be declared then it is expected that a range of activities would occur across Australia.

In 1994 ACEC will run under the banner of APITITE '94 (Asia Pacific Information Technology in Training and Education 1994). This will be an umbrella conference for three conferences: ACEC'94, ITTE '94 and ASCILITE '94. It will be held at the Brisbane Entertainment Centre from June 28 to July 2, 1994.

ACCE involvement with the National Statement on Technology continues — in fact I was recently elected President of TEFA (Technology Education Federation of Australia). By now all CEG members should have received a condensed version of the Statement. Also by this time capital city workshops are being staged to further enlighten teachers of what the Statement is about and what it may mean for classroom practice. These workshops are being funded by TEFA and I would urge you to become involved.

The Statement is still in interim form with final publication due around the middle of 1993. The ACCE has major concerns (still!) over parts of the Statement — particularly the Information strand. I will continue to lobby for changes. The Technology Profile is also currently under development. The draft Profile is scheduled to be completed by mid October, with validation occurring later this year and the trialing to take place early in 1993.

In addition to the above the Curriculum Corporation is initiating a Technology Curriculum Teaching Project (TCTP) early next year. As with all the other documents relating to Technology this is about six months later than was initially planned. The TCTP aims to provide a range of curriculum support materials to facilitate the implementation of the Statement.

As of next year there will be some changes to this journal, *Australian Education Computing*. It is likely to undergo a name change to better reflect the broadening use of computers and related technologies. Also a refereed section will be introduced to raise the status of the journal and as an incentive for academics to publish research projects etc. Publication of the journal will remain the responsibility of QSITE who are subcontracting it to the Research into Information Technology Group at Queensland University of Technology. This should increase further the quality of the journal.

ACCE continues to be involved in a number of national forums including the National Education Forum, responding again to the Mayer competencies and having input to the proposed National Teaching Council. If you feel there are areas that the ACCE should be further involved in I would welcome your input.

Ian Webb, President

Sharing the Vision

Australian Computers in Education Conference

Panthers Convention Centre, Penrith, New South Wales

28th June to 1st July 1993

THE LEFT-HANDED COMPUTER — *alternative images of classroom computing*

Carolyn Dowling
AUSTRALIAN CATHOLIC UNIVERSITY (VICTORIA), MERCY CAMPUS

In recent years considerable concern has been voiced by educators in regard to the models of thinking, learning and decision-making endorsed and amplified by the majority of computer-based activities. While some possibilities for the encouragement of the type of open-ended activity commonly described as 'creative' do exist, the most prevalent mode of use is related to the achievement of a predetermined product, through the application of step-by-step logic to a perceived 'problem'. In such circumstances, attributes such as accuracy, speed, efficiency and predictability are valued above such qualities as vagueness or uncertainty of outcome.

The development of alternative models of thinking within the field of artificial intelligence supports the suggestion that other quite different styles of computer use may be possible, particularly in areas where the digital-processing and Cartesian mode of logical thought most commonly associated with computers are not necessarily appropriate.

In recent years considerable concern has been voiced by educators in regard to the models of thinking, learning and decision-making endorsed and amplified by the majority of computer-based activities (Bowers 1988, 1991, 1992). The computer is an artefact which is highly consonant with a particular subset of cultural goals and aspirations within our society. As portrayed in the popular media it is most commonly associated with the corporate image of men in suits moving rapidly (generally in upwardly moving elevators) from one decision-making situation to another. It is rare to find the computer associated publicly with the more exploratory or contemplative modes of life.

Such a characterisation of the computer as a 'tool' for the efficient achievement of clearly defined and instrumentally constrained ends may appear to be in conflict with much of the rhetoric of educators concerning this particular model of classroom computing, where the notion of a tool is closely associated with ideas of the empowerment of the individual in the service of personally formulated goals (Taylor 1980). While it can be argued (Bowers 1988, 1992) that such a conception is itself in some conflict both with a number of philosophical positions and with aspects of contemporary educational theory such as that concerning the social construction of knowledge, this may be of less concern than might be feared, since it contrasts significantly with the uses to which the computer is most often put.

In practice, the majority of computing activities in the classroom are curriculum driven and relate to externally imposed goals. The computer is in most cases used by the student to achieve ends largely defined by the teacher. Rarely are children given the opportunity to construct and explore their own subject domains. As I have written elsewhere, 'The computer is a tool for the carpenter rather than the sculptor' (Dowling 1990). While some possibilities for the encouragement of the type of open-ended activity commonly described as 'creative' do exist, the most prevalent mode of use is related to the achievement of a predetermined product through the application of step-by-step logic to a perceived 'problem'. In such circumstances, attributes such as accuracy, speed and predictability are valued above such qualities as vagueness or uncertainty of outcome.

Education is most commonly seen, particularly by those outside it, as concerned for the most part with the imposition of order, logic and discipline upon the chaos of the unschooled mind and upon the undesirable irregularities of life as we experience it. Some time ago I attended a school council meeting at which a number of members were most vocal concerning the point that raffles were a threat to the fundamental ethos of the school. The school was described by one speaker as being 'about order and structure', while raffles were perceived as being antithetical to such values. At around the same time a letter appeared in the local paper deploring the use of choose-your-own-adventure books in school, on the grounds that they appeared to 'endorse a model of decision making ... where decisions are made on the throw of a dice.' The letter continues:

> In an increasingly complex society, it is

> surely the role of educators to encourage the young to seek knowledge, acquire understanding, explore options and make decisions based on reason and morality. The model endorsed by (the book in question) represents at best an opting out of responsible decision-making, at worst a retreat into chaos and unreason. Our young people deserve better (Simpson 1989).

Such perceptions of education fit comfortably with most images of computer use, not simply as practised in the commercial world, but equally as reflected in many of the better known projects in the area of artificial intelligence, along with obvious resonances concerning models of the workings of the human mind (Papert 1991). But if the computer has, as is sometimes suggested, a special role to play as a tool *for* the mind, is it necessary and inevitable that it should so conspicuously support one 'side' as it were, of the mind's activity, to the effective exclusion of the other, or others? (Dowling 1986,1990) This is an important issue, since it is increasingly common in contemporary thinking for particular types of activity to be not simply supported but validated by the involvement of computing technology, to the detriment of other modes of thought and action.

The development of alternative models of thinking within the fields of artificial intelligence and cognitive science, particularly in connection with neural networks and emergent behaviour, supports the suggestion that other quite different styles of computer use may be possible, especially in areas where the digital processing and the Cartesian mode of logical thought most commonly associated with computers are not particularly helpful (Papert 1991).

We recognise that not all human endeavour is directed towards the achievement of preconceived goals, and that new ideas, understandings and creations do not necessarily arise from the application of a series of clearly defined logical steps to a piece of existing knowledge. In many instances, in fact, it is from the disordering of customary perceptions and of accepted modes of thought and action that the most prized expressions of ourselves and of our culture stem. A large part of our conscious and perhaps our unconscious existence is devoted not to linear problem solving, but to mental, physical and emotional 'puddling about' — the 'primal ooze', if you like — from which much of what we applaud as creative achievement arises. As Fielden puts it, summarising the views of several writers, 'creativity involves a relaxing of controls and a letting go of rational thought processes.' She contrasts such an approach with traditional concerns of technical education, in particular that concerned with the use of computers, which 'is about refining and perfecting rational thinking' (Fielden 1992).

In discussing some of the implications of what he characterises as the 'new' AI, Papert questions the desirability of limiting our conceptions of thinking and learning to the linear Cartesian model concerned with the step-by-step development of concepts, at a time when, as he puts it, the very concept of a concept is under significant threat. 'Get it right. Be consistent. Be logical. Or ... are these things really restrictions? Do they cramp the spirit of the working of the mind? Do they impede learning?' (Papert 1991)

If alternative modes of thinking are not afforded the value we would hope for in the classroom, we should recognise the part played by the computer in offering support to an ethos which is largely contrary to such types of activity. Perhaps the most effective means of counteracting this emphasis on the virtues of the immediately instrumental, the logical, the digital in our thinking is to enlist the computer itself as member of our team. Is this possible, and to what extent?

One might argue that the extensive use of graphics and word processing packages and to a growing extent hyper- and multimedia software in the classroom points to a well established base of open-ended, creative uses of computers. While clearly this is so in some cases, I would suggest that the details of how these programs are used most commonly reveal a number of restrictive practices. In the case of word processing, for example, even in cases where the computer is used as a tool for composition rather than as an up-market typewriter, the act of writing is set about with regulations pertaining to choice of topic, the number and manner of drafts undertaken, the format and language which is acceptable within particular established genres, the degree of 'complexity' of sentences deemed to be desirable, and so on. The teaching of writing as facilitated by the computer results all too often in a lively and individual piece of expression being transformed into blandly acceptable prose whose dreary uniformity is reflected in the over-conventionalised appearance of the hard copy.

What else could we be doing with computers? In his introduction to Silverman's *The Phantom Fishtank* (1987), a series of provocative 'game of life' programs designed for educational use, Papert writes: '... a whole software industry is committed to the idea that programmers will make computers do what they are told — no more and no less. But there are times when the thrill comes from the computer doing something that one did not anticipate and perhaps could not have imagined even if one has tried. The excitement is not what was specified but in what emerges' (Papert 1987). As mentioned earlier, this is a theme upon which he has expanded more recently in connection with the new images of thinking, learning and computing associated with changing emphases in artificial intelligence research.

Potential classroom applications of such an approach are exemplified by the work of Resnick in creating and exploring computing environments for children based on a decentralised model of computation and of behaviour (Resnick 1991). Here we recognise some of the ways of thinking which characterise the work of chaos theorists, and which are familiar to many computer-using teachers and to a number of students within this context. The relation of randomness to order, the significance of small changes to the configuration of the whole, the degree of complexity which can emerge from a few simple rules and, very importantly,

> ***If the computer has, as is sometimes suggested, a special role to play as a tool*** **for** ***the mind, is it necessary and inevitable that it should so conspicuously support one 'side' as it were, of the mind's activity, to the effective exclusion of the other, or others?***

an acceptance of the principle of unpredictability in any sense that we currently understand it, are some of the elements of this way of looking at the world.

In his writing Resnick is careful to point out that what he terms a 'decentralized mindset' is not to be regarded as appropriate or desirable in all situations, but it is certainly encouraging to see such altemative modes of thinking and of computing set against those assumptions which have until now gone largely unchallenged, regarding the 'proper' uses of the mind and of computers.

On more familiar ground, in Australia as elsewhere there is a well established tradition of Logo being used in an open-ended, exploratory way, in contrast to the teaching of programming in the interests of more traditional forms of problem solving. Such an approach is reflected in Wills' phrase, 'Doodle, Design, Debug' (1985). A similar emphasis permeates Nevile and Dowling's *Let's Talk Apple Turtle* and succeeding books, in which a string of Logo commands typed without initial regard to details of the outcome forms the starting point for all activities.

The work of Idit Harel (Harel & Papert 1991) conceming chidren as software designers, an account of which was presented at WCCE '90 in Sydney, is of particular interest in relation to the emphasis placed on the degree of choice given to the students in developing and articulating their own goals, and the means by which they achieve them. While the emphasis on design within the context of theories of constructionism as espoused by those connected with the MIT Media Laboratory (Harel & Papert 1991) resonates in many respects with current popularity of the term within Australian educational circles, particularly in relation to technology education, there are interesting differences, particularly in regard to the requirement which often seems to be assumed, that design activity be judged in terms of practical outcomes.

While the requirement that a product have meaning in terms of its cultural context is often cited as one of the criteria for a 'creative' act to be accepted as such, it is by no means the case that perceived utility and functionality are necessary prerequisites for such an acknowledgement. Such a bias is evident within classroom computing when the philosophy of 'debugging' is put at the service of getting programs, however mundane, to 'work', rather than encouraging exploratory modifications which might possibly lead to new and quite unexpected insights and outcomes. Deplanning, or flexibility of goals is frequently discussed as though it reflects a disability on the part of the learner, rather than being a positive attribute which can often lead to more original, complex, even more appropriate results than those suggested by the initial goal or concept. The element of surprise is too rarely extolled in educational circles for its capacity to provoke deep and sustained thought and creative enterprise.

The computer as a cultural icon of considerable power has the capacity, through its tacit validation of selected models of perception, and thought, to set our minds in concrete. It can be the supreme vehicle for the consolidation and preservation of a particular set of attitudes and values, perhaps most notably in relation to what might be termed instrumentalist modes of interaction with the world. It is therefore important that we devote serious attention to the possibility of encouraging altemative types of computing, particularly in the classroom, since we might reasonably expect that the image of the computer which children encounter during their years of schooling is likely to strongly influence the use they make of the technology in later life. Left-handed computing might be a minority activity, but it may well turn out to be significant in maintaining a balance within our culture between alternative ways of thinking and doing.

> ***The element of surprise is too rarely extolled in educational circles for its capacity to provoke deep and sustained thought and creative enterprise.***

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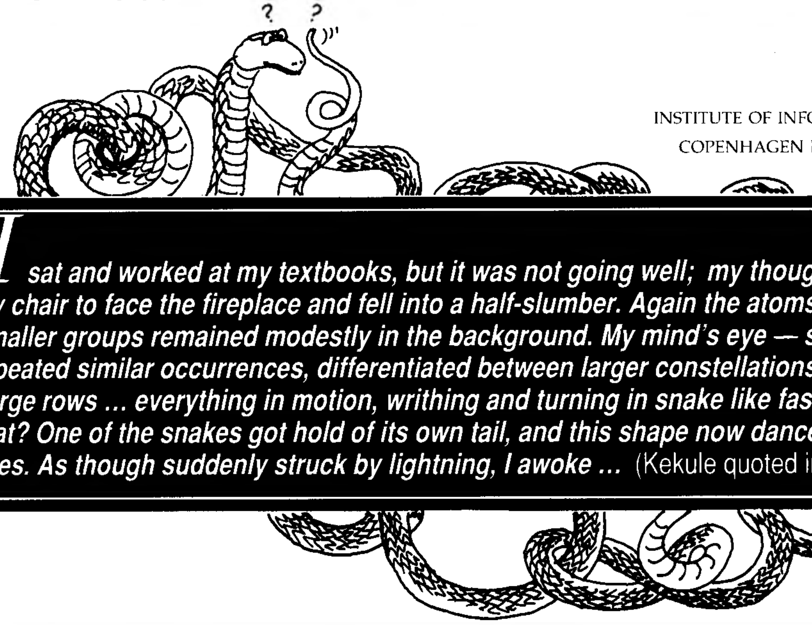
IT IS MORE THAN JUST SEEING —
on multimedia and visual thinking



Janni Nielsen
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> *I sat and worked at my textbooks, but it was not going well; my thoughts were elsewhere. I turned my chair to face the fireplace and fell into a half-slumber. Again the atoms danced before my eyes. Smaller groups remained modestly in the background. My mind's eye — shuffled as a result of repeated similar occurrences, differentiated between larger constellations, of multifaceted forms. Large rows ... everything in motion, writhing and turning in snake like fashion. And look, what was that? One of the snakes got hold of its own tail, and this shape now danced mockingly before my very eyes. As though suddenly struck by lightning, I awoke ...* (Kekule quoted in Walgenbach 1984, p. 268).

Kekule is describing how — in 1890 — he discovered the benzol ring. It was not the text which made him see the light. On the contrary, the new insight was born from an associative, half conscious perception of visual dynamic images: the snakes dance, and one of them, and notice this — mockingly — gets hold of its own tail. Was it mockingly because the scientific discovery was right there before his very eyes, but he could not see it because of all the words? It was seeing with the mind's eye which was the basis for a new understanding, and it was imagination which played a crucial role in bringing forward a new scientific discovery.

It is this ability to imagine things, to disregard the written word, and see the meaning in a visual image which catches my attention, because the human being is a visual being. It is with the eyes we meet the world. And whether it is images in the outer world, or images seen with our mind's eye, it is visual perception which rules.[1]

Yet we live in a language culture, a western culture in which knowledge acquisition and learning is understood as being based in language. The technological development, however, points towards a future of multimedia, with a growing use of icons, dynamic graphics, video etc. Whether one speaks of advanced systems designed for power-stations or for educational use, increasing amounts of information will be in the form of visual dynamic images, which have to be read and understood. Systems will be multimedia visual systems. This means that alongside, and interacting with — sometimes overriding — the language culture, there will be an image culture.

Once upon a time the human species did not possess a written language. They communicated and expressed their knowledge by drawing images on cave walls. Over thousands and thousands and thousands of generations, the humans have invented, developed and refined languages. At the same time we have also developed and refined our cognitive qualifications. Instead of communicating via drawings we can express knowledge through language. We can read the thoughts and ideas of other people and through this rather abstract mental activity try to understand the message. Thus developing language as a tool for communication and for the intellect, definitely enhanced our cognitive development.

There is every reason to expect that the new visual multimedia will demand new cognitive qualifications. A very essential one will be the ability to critically read visual images.

TEXT AND/OR GRAPHICS

In a research project I wanted to carry out an empirical investigation of the influence of image representation and written information on cognitive processes. To enhance this goal I chose a simple software program[2] in which text/dynamic graphics were integrated. This would allow the learner both a symbolic approach and/or a graphical approach to the task.

The research was based on a qualitative investigation of 36 novice users — age 15–16 — who were videotaped[3] during their work with the computers. The empirical data were collected in two steps. First a group of schoolchildren who worked with the Danish edition of Logo in their math classes was investigated. The second step was an investigation of a group of adults who participated in a computer course.

The novices were given an introduction to computers with 6–10 hours hands-on experience. This included instructions from a teacher and they worked through different examples together with the teacher. Following this the participants were given different problems to solve.[4] They worked in pairs, and the following sources of information were available to them:

- verbal explicit help and instructions;
- instructions on blackboard;
- written explanations in the form of a manual;
- a book with exercises including explanations and illustrations;
- a list of system commands; and
- the information on the screen being both text and/or graphics.

THE SEDUCTION

The analysis showed, that irrespective of age, there was a clear preference for the dynamic graphics. Only very few were able to handle the programming approach.[5] Nevertheless they succeeded reasonably well in solving problems. It was not always the problems posed, but they wrote functional programs. However, this happened only if they relied on their visual perception, because the words worked as a hindrance (Nielsen 1987). Initially this was no problem, because they were clearly fascinated by the dynamic images. They all possessed, one may say, the very special ability of allowing themselves to be seduced by the graphics (Nielsen & Lisbeth 1985).

THE ENCHANTMENT

The dynamic graphics functioned as an enchantment, and to some of the participants this also worked as a hindrance. This happened when they got 'caught' by the graphics, when the visual images ruled. The graphic forms and in some cases also the dynamic movements captured their attention to the extent that they never sought beyond the dynamic image, hence it was not made the object of analysis. The immediate visual sight was sufficient for them. As a consequence the dynamic graphics led to a fixation (Nielsen 1988).

THE ENHANCEMENT

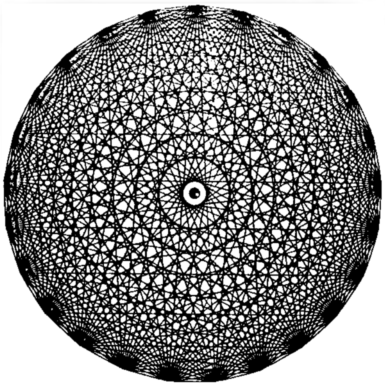
To other students the dynamic graphics would promote the learning process. When successful they would move beyond the immediately perceivable and try to grasp the information embedded in the graphics. They would stare at the screen, their eyes glued to the cursor, heads nodding, following its moves. They would venture interpretations, voice assumptions and comment on the stepwise movements. 'Yes, that's it, we are turning to the right, now it should finish the circle and move out again' (Nielsen 1987). They would solve the problems by reading and debugging the dynamic graphics — not the programs. In these cases I found that the dynamic graphics enhanced learning, hence understanding.

THE PRIMARY SOURCE OF INFORMATION

However, whether they succeeded or not, the dynamic graphics were the most important source of information. It was primarily the dynamic graphics — not the program or the priority defined logic embedded in the programming, nor other kinds of information and explanations — which they would rely on, respectively read and debug.[6]

Yet the adults would state during an interview carried out prior to the work with computers, that given a choice, they would primarily rely on written instructions. After the work with the computers were completed, they stated again that the written instructions — exercise book or manual — had been the main information sources.

It is with the eyes we meet the world. And whether it is images in the outer world, or images seen with our mind's eye, it is visual perception which rules.



Confronted with the videotapes, they were surprised, some of them even expressed shock when realising that they primarily relied on the dynamic graphics and the illustrations in the exercise book. They lived in a language culture, and were not aware of the extent to which they relied on information in the form of visual images.

VISUAL THINKING

Yet they were able to write functional programs. But the analysis also showed that it was not sufficient merely to see the graphics. They also had to be able to operationalise the visual knowledge gained, that is they had to be able to read the dynamic graphics. Failing to read the information embedded in the graphics, they were lost.

To explain some of the cognitive processes at work, I should like to introduce the concept of tacit knowledge (Polanyi 1968).

INDEFINABLE INSIGHTS

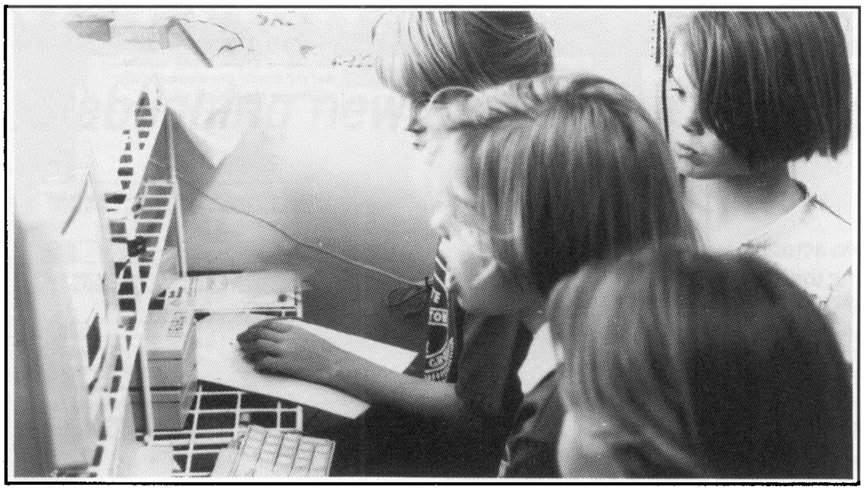
M. Polanyi has given exceptional and profound contributions to the discussion on the nature of scientific knowledge. He makes a distinction between logical knowledge and psychological knowledge and according to Polanyi the latter is the ground upon which scientific knowledge rests. He discusses 'the indeterminacy in scientific knowledge' (p. 27) and argues that fundamentally knowledge rests upon an indeterminacy in content, in the coherence we see which will always be vaguely defined, as well as in the data upon which we base our results.

Polanyi perceives science as an 'extension of perception', a way of seeing reality in gestalts, and in his analysis he focuses upon the cognitive process of visual perception and shows through examples, that what is true for scientific knowledge is also true for other kinds of knowledge.

Polanyi suggests that 'explanations must be understood as a particular form of insight' (p. 38). This implies that there are other kinds of insights, other kinds of understanding and other kinds of knowledge. It is the other kinds — the tacit knowledge which are of special interest to Polanyi, and he introduces these non-explicit or indefinable insights through examples of indeterminacy in knowledge, where he shows that 'we know far more than we can tell' (p. 30).

TACIT INTERFERENCE

The development of tacit knowledge and the tacit inference is intertwined with our awareness, and Polanyi distinguishes between focal awareness and subsidiary awareness. Reading this text, the focal awareness is not oriented towards each single letter, nor towards each single word or the sequence of the words. All of these elements function as subsidiaries for the focal awareness which is oriented towards what the reading is all about: the meaning of the text. The relationship between the letters, the words, the sentences is created via a tacit inference, via the cognitive ability of gaining insight. It is the same kind of tacit inference which takes place when one is looking through a stereoscope. Looking with only one eye, one sees one image. Looking with



the other eye, one sees another image. Looking with both eyes, an image which — one may say — is not there, is created. The eyes see a relation or rather a coherence which is created by the tacit inference from the two images, and born — or imagined — in a third image. Thus one sees more than what is visible, and the underlying process is that of visual perception, of trying to gestalt, to make sense of what is seen.

MORE THAN JUST SEEING

With this understanding of visual perception, it should be no surprise then, that the most important source of information was the dynamic graphics.

The students were seduced by the graphics. Yet information in the form of visual images does not always enhance insight and understanding, though it may enchant. To some of the students the seduction would turn into an imprisonment. This could be a result of an expected graphical outcome not showing up on the screen. One could almost say that a breakdown in the 'communication' occurred. They did not seem to have fully grasped the wholeness, or the interrelatedness of the graphics. As a result the process would often be trial and error and eventually haphazard changes. Most often they would get lost in the attempts to change the program in order to obtain a wanted result. As a consequence, they lost the overall view, and sometimes experienced the frantic changes as if they were moving in a maze. Others were so fascinated by the dynamic graphics, that even when the cursor's only moves were to circle around itself, they would laugh with expectant smiles on their faces, 'Did we ask it to do that?, They would have their eyes glued to the screen, and with screams of laughter repeat the experience, 'let's make it do it again' (Nielsen 1986). Or they would be so fascinated by the graphical shapes, that they would perceive the form, no matter what, as the meaning of the activity. As a result no analysis would be attempted and not much understanding would be acquired. The students' awareness became 'frozen' in the graphical result on the screen. Attempts of indwelling were few, because the immediate fascination was so strong.

The students who, with success, relied on graphics, did so because they allowed their visual perception to rule, following the dynamic graphics so carefully that they were 'down there in the screen', moving around with the cursor. 'Pouring one's body into it' is how Polanyi describes the process (p. 33), and he argues that only through this ability to project our senses out into an external space is essential knowledge gained, which could not be acquired by an act of detached intellectual contemplation. In this act of indwelling, the students do not focus on each particular step of the cursor, but these movements rather function as subsidiaries guiding the awareness away from each step and towards an integration of all the particular movements into an image — a coherent gestalt. It is a perceptual integration established through an inference.

Of course the students, when looking at the screen, are aware of each step of the cursor. The fact that their eyes are following the cursor around, and their heads are nodding, tells us that. However, this is not the focus of the attention, or rather they are aware of the artificial steps in some unfocal way. The steps are perceived in relation to the whole, and the students make sense of what they see by establishing a coherence between the steps. Part of what they see is incoherent, but they gestalt an indeterminable coherence by imagining a joint image.

Their inference is based on the graphics which lead to understanding. It is not the result of detached contemplation. On the contrary, this is a spontaneous event, it happens suddenly and is never explicitly verbalised. Polanyi speaks of it as a tacit inference and sees it as a result of intuitive processes, of knowing more, or maybe seeing more that there is to see.

DISCUSSION

I should like to turn back to the question of visual thinking and I will suggest that thinking is neither language, nor pictures nor logic. These may function as subsidiary tools for the thinking. Thinking I have come to understand as 'condensation of meaning, insights which initially neither exist in language nor in pictures' (Dirckinck-Holmfeld & Nielsen 1992). We have all experienced how a very clear idea of how to proceed with a given problem, becomes completely muddled up when we try to write it down on paper.

New insights and understandings may be perceived as 'flashes' where one see's something which one has never seen before. Like Kekule, who saw the snake dancing before him, and getting hold of its own tail. A state or experience like this is indeterminant, irreversible and tacit.[7]

Under many conditions this kind of tacit knowing may be superior. However, in other connections tacit knowing is fundamental, but not sufficient in itself. In learning processes the aim will be to penetrate as deeply as possible into the understanding based on tacit inference, in order to acquire a conscious and articulate understanding of the tacit inference.

In order to open up for profound and fundamental understanding multimedia may enhance the processes because it embodies an element of seduction which enhances the learner's access to indwelling. It also offers a way to concretise and visualise dynamic images which may enhance the student's comprehensive view. Just as it is a force and because it may stimulate exploration. However, the seduction is dangerous if it lures the students into focusing their awareness on subsidiaries, instead of the meaning of the message.

This ambiguity will also be true of sophisticated designs of the future, and as pointed out, it is not sufficient to become enchanted and merely see, one has to be able to read the images and see coherences where no coherence is. I will suggest that an essential cognitive qualification needed in the interaction with the multimedia systems is that of visual operational thinking.[8] Human beings already possess this ability to grasp graphics, only to some extent it needs to be further qualified.

END NOTES

[1] There is, of course, a difference between actually seeing the blue sky and imagining seeing the blue sky. But for now, my interest is the cognitive processes which make sense of what one sees, whether it be actual or imagined.

[2] The Logo program was very easy to handle. The philosophy behind the design was that a child should be able to use it without too much practice. Exactly because it was designed in order to promote easy access for children it was, in terms of software development, a very advanced tool.

[3] The advantage of this method is obvious. The working process I captured, in detail, on the screen. The total process is visible, an 'eternal' documentation. Others may work with you on the interpretations. The participants themselves — as in this case — can participate in the analysis. Especially when breakdowns occur, this has proved extremely useful.

[4] Example of an illustration showing a triangle which was turning and at the same time growing in size, was shown. The instructions would then be to try to write a program which would execute a similar form.

[5] The tapes showed that only a young man of age 15, after make a change in a subroutine, mentally integrate it into a super-routine, and predict the outcome.

[6] This was even true one year later, after approximately 50–60 hours of programming experience (Nielsen 1989). The preference for graphics is also documented in a working paper by Hoyles and Noss (1987) — though this is not a conclusion the authors draw.

[7] Of course he had to state it explic-itly, in order to communicate the experience to others. This is fundamental for all human life. Language is an extremely important tool for the intellect, in communication etc. However, this is not the axe I want to grind here, my aim is to discuss the role of visual thinking.

[8] Another necessary cognitive qualification is the ability to navigate in these systems and keep track of where one is. This qualification I have termed: a mental spatial mapping ability.

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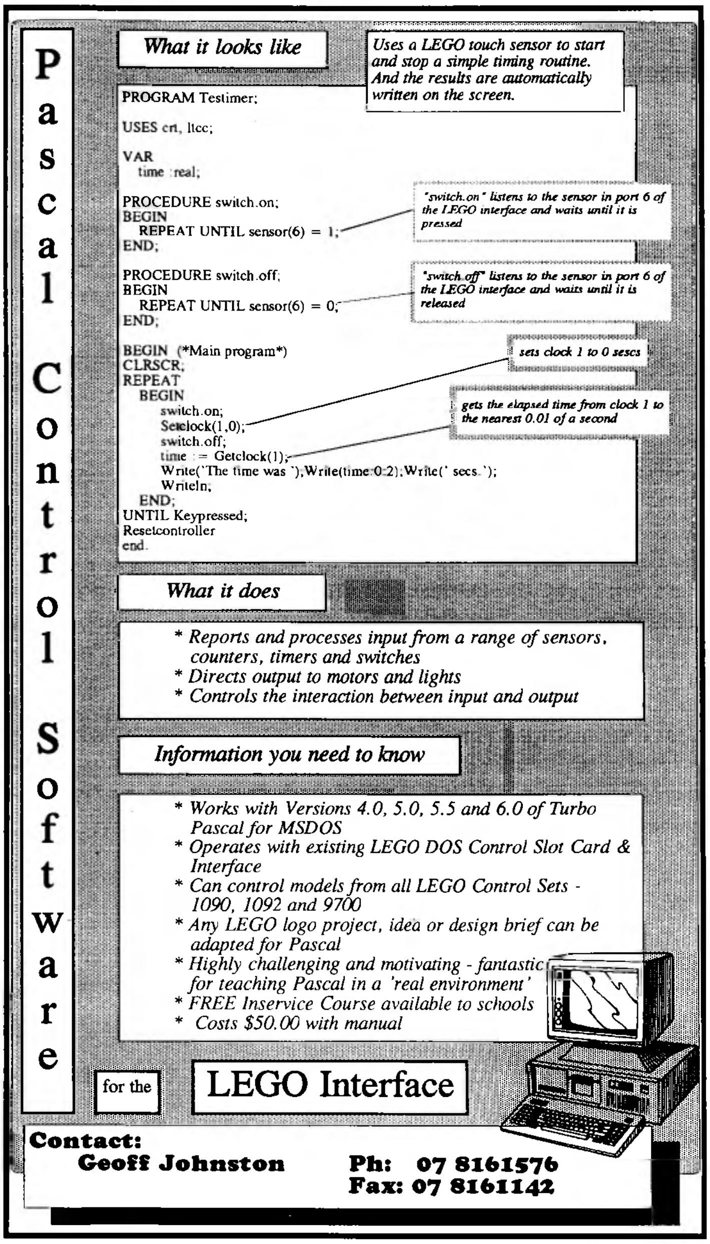

Pascal Control Software

What it looks like

Uses a LEGO touch sensor to start and stop a simple timing routine. And the results are automatically written on the screen.

```
PROGRAM Testimer;

USES crt, ltcc;

VAR
   time :real;

PROCEDURE switch.on;
BEGIN
   REPEAT UNTIL sensor(6) = 1;
END;

PROCEDURE switch.off;
BEGIN
   REPEAT UNTIL sensor(6) = 0;
END;

BEGIN  (*Main program*)
CLRSCR;
REPEAT
   BEGIN
      switch.on;
      Setclock(1,0);
      switch.off;
      time := Getclock(1);
      Write('The time was ');Write(time:0:2);Write(' secs.');
      Writeln;
   END;
UNTIL Keypressed;
Resetcontroller
end.
```

"switch.on" listens to the sensor in port 6 of the LEGO interface and waits until it is pressed

"switch.off" listens to the sensor in port 6 of the LEGO interface and waits until it is released

sets clock 1 to 0 sescs

gets the elapsed time from clock 1 to the nearest 0.01 of a second

What it does

* Reports and processes input from a range of sensors, counters, timers and switches
* Directs output to motors and lights
* Controls the interaction between input and output

Information you need to know

* Works with Versions 4.0, 5.0, 5.5 and 6.0 of Turbo Pascal for MSDOS
* Operates with existing LEGO DOS Control Slot Card & Interface
* Can control models from all LEGO Control Sets - 1090, 1092 and 9700
* Any LEGO logo project, idea or design brief can be adapted for Pascal
* Highly challenging and motivating - fantastic for teaching Pascal in a 'real environment'
* FREE Inservice Course available to schools
* Costs $50.00 with manual

for the LEGO Interface

Contact:
Geoff Johnston **Ph: 07 8161576**
Fax: 07 8161142

MULTIMEDIA –

establishing new paradigms or reaffirming old skills

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> *The term multimedia has become, for good or ill, the latest in a long line of developments in the computing world which is being touted as being the solution to all of the problems of education. It is unfortunate that the important underlying concepts which are at the core of multimedia are being overwhelmed by the hyperbole which surrounds them.*

The term multimedia has become, for good or ill, the latest in a long line of developments in the computing world which is being touted as being the solution to all of the problems of education. It is unfortunate that the important underlying concepts which are at the core of multimedia are being overwhelmed by the hyperbole which surrounds them.

Multimedia is seen as being important to education because it holds a promise of improving the quality of education by providing students of all ages with opportunities to access a wide range of information types. It enables students to experience this information via multiple channels of communication and encourages active learning. By permitting the learner to access and manipulate information via the computer, multimedia encourages active participation in learning and the development of accurate information retrieval techniques leading to restructuring of elements which consider as being the constituent elements of, and means of acquiring, knowledge are being redefined.

In recent work Fred D'Ignazio (1991) stresses the fact that in order to maximise educational gain from the potential of multimedia there needs to be considerable change in the methods, attitudes and the nature of curriculum practices used by teachers. He maintains that while multimedia has considerable potential, its benefits will be lost if there is not radical reassessment of not only the means by which students and teachers learn but also the relationship which exists between teacher and taught.

This article will attempt to outline several issues which need to be addressed no matter which level multimedia is employed as an aid in developing skills and processes in education. The issues presented in the article are those which emerged from consultation and discussions undertaken with teachers using multimedia in the classroom. The teachers were drawn from four schools — two primary and two secondary — and participated in an investigation into the educational value of multimedia when used in the classroom. The schools were provided with a combination of IBM-PC compatible, Macintosh and Apple II series computers. Software, ranging from relatively simple applications such as *Super Story Tree* to complex programs such as *Macromind Director* and *Linkway*, were also provided. The teachers in the primary schools used the resources in social studies and language arts; while those in the secondary schools used multimedia as part of their geography and journalism programs.

In essence the issues fall into four interrelated components:

- the implications of multimedia format for student learning
- the implications of the use of interactive multimedia technology upon teachers and learning strategies and classroom management
- curriculum implications of the use of interactive multimedia technology
- implications for teachers' roles and professional development needs.

In European cultures there has been, and in certain quarters still is, a preference for print as the favoured form of communication. Multimedia, however, by its very nature requires the integration of several types of communication channels, (i.e. print, visual, auditory) which are fused into an holistic presentation. One of the central issues which has emerged is the need for reassessment of and reorientation of the values placed upon the different modes of communication. The increased use of integrated multimedia presentations which combine several communication channels points to the necessity for an evaluation of the effectiveness of this type of learning environment.

It is essential to recognise that in this multimedia environment that visual, auditory, text and graphical components of a student's multimedia document are of equal value. The combination of these elements to form a multi-modal text, combined with the interactivity that students and teachers can build into their work, provides a new and stimulating educational environment about which we know relatively little.

MULTIMEDIA FORMAT AND STUDENT LEARNING

Since the use of multimedia software requires students to comprehend and compose multimodal texts, the study of the creation of meaning in multimodal texts becomes increasingly important.

Discussions with teachers, at primary and secondary levels, involved in the production of the multimedia presentations have indicated that both teachers and students need to develop the skills, processes, attitudes and knowledge required to effectively compose, comprehend and communicate in multimodal texts. Teachers and students found that their early attempts to use this type of software resulted in work which displayed virtuosity with the software rather than concentrate upon clear and effective communication. Early work with multimedia formats reflected the early attempts with desktop publishing where users are overwhelmed by the richness of their environment and used many different fonts and style on one page.

Only with the early experience behind them was there an appreciation of the importance of consistency in screen design and layout production techniques including identical means of linking on screen of information with another (e.g. via a particular type of fade/wipe/dissolve). It was also evident that using 'off the shelf' audio clips provided by the software package could prove to be distracting to the audience and contribute little to the meaning of the work in hand.

SEQUENCING

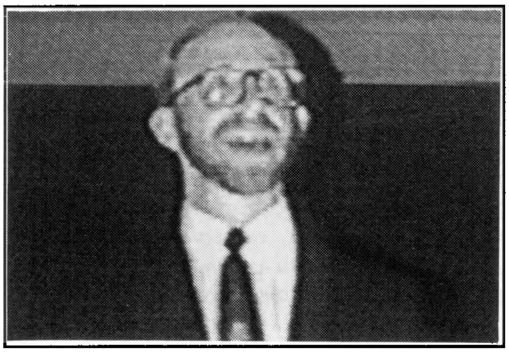
It is also important that students and teachers are aware of the implications and effects of the sequencing and complexities of their work. It became apparent that the very complexity of these programs also contained within them the seeds of confusion.

It is important therefore to recognise that the process of sequencing will focus the manner in which information is accessed by the users and consequently it directs and constrains the range of meanings available to the audience. While this theoretical perspective is accurate it was that in some cases classroom use indicated that the sequencing process in itself could provide too many paths for the user. Experience indicated that unless there was an overview or 'concept map' of the whole presentation to provide a user with a sense of direction and location, in effect a 'big picture', of his or her position in the presentation, that student would become lost and the opportunities for interaction became opportunities for distraction.

To avoid the distraction, confusion and consequent loss of direction on the part of the user the participants in the investigation realised that an understanding that every word, sound, image, screen layout and indeed the design linking the presentation elements needs to be constructed on the basis of its contribution to the meaning making process. It also became apparent that for effective communication to occur the audience likely to use the presentation had to be considered on their own terms of reference (e.g. the level of comprehension for early primary differed from that of senior secondary). This process of focusing upon the audience also meant that an explicit recognition of the nature and complexity of the information being presented had to be tailored to maximise its effect and in doing reinforced the contextual nature of multimedia within present teaching guidelines.

Interactivity represents a key element in multimedia, especially in education, but the nature and degree of interactivity also represented one of the major areas which had to be addressed before commencing the construction of the interactive text. The participants in the project found that, to be effective, the design of screens and the level of interactivity not only required an understanding of the potential of software to combine text, graphic, images and audio elements but also a clear understanding of the project's overall aims and objectives.

Fred D'Ignazio maintains that while multimedia has considerable potential, its benefits will be lost if there is not radical reassessment of not only the means by which students and teachers learn but also the relationship which exists between teacher and taught.



It was essential that before a project commenced that a clear picture of the structure of the interactive program was defined. This process was usually undertaken by cooperating in the design of a story board or flow chart which indicated the type, number and direction of the paths which would become available to the user. The wide range of resources which could be drawn upon, and their seductiveness in terms of information which could be included, made this design process essential both in defining the designers' intentions and in ensuring that members of the group were fully aware of the type of tasks being undertaken. It was also clear that such a clear definition became possible only when the designers had developed a series of questions which not only served to define their own intentions clearly, but also communicated those intentions to the audience of the program. In doing so the student designers were in effect establishing the conditions for learning (Gagne 1966).

STUDENT-CENTRED LEARNING AND MULTIMEDIA

Multimedia in the classroom moves the focus away from the teacher's traditional position as a leader of learning towards a much more clearly defined student-centred approach to learning. In doing so using multimedia also alters the relationship between student and teacher emphasising the necessity of mutual cooperation, clarity of thinking and the development of both interdependence and independence on the part of the students. The teacher is able to move from one of attempting to cater for a wide range of abilities on the basis of compromise to one where he/she can develop individual or small group extension programs which can be negotiated with students. Once the multimedia process is firmly established within the classroom it becomes possible for the teacher to give more attention to those students requiring additional support.

In such a situation it is vital that the students undertaking multimedia program design are able to clearly formulate their hypotheses or questions which are to be the bases of the investigation. The processes which the student groups developed indicated that the construction process of the multimedia presentation was significant not only in itself but also in helping to develop their problem-solving skills.

One of the experiences which teachers in the project found disconcerting was the degree to which it was necessary to inculcate a culture of enquiry among students and to encourage them to take responsibility for their own role in a decision making process (Gott 1988). Past experience on the students' part was one in which decisions were not required or were confined to choosing from a limited range of clearly defined options. Multimedia was a strange territory which they entered on their own terms, defining their objectives and establishing their own guidelines, and teachers noted that even after undergoing programs to help them build their self-confidence that some students would still turn to the teacher for detailed guidance.

By constructing their own terms of reference students are able to undertake an information gathering process which allowed them to follow paths determined beforehand and to follow up interesting materials gathered incidentally during this process. The acquisition of these materials also permits them to explore the relationships and nature of the links between materials as well as developing their own relationship with the multimedia materials to be integrated into their programs.

The user not only gathers information but also then makes effective use of the information so gathered by collating, synthesising, prioritising and analysing it to fit the purposes established beforehand. During this process the skills developed can be employed to maximise the student's capacity not only to gather multimedia information but also, by actively linking this information, to participate in the pursuit of individually developed associations.

Both teachers and students found that this information gathering process, which was undertaken with specifically defined objectives in mind, also served to develop small group skills and the capacity to share information and develop problem-solving skills. While the information gathering process resulted in the accumulation of materials for inclusion in the presentation it also laid the foundation of a cooperative learning process which continued during the multimedia construction itself. It also became apparent that while a considerable amount of cooperative learning occurred during this period that the students also shared several different roles during the construction process.

Teachers and students found that it was possible to develop a better perception of how individual elements in a process were related. Much of this appreciation occurred at the planning stage when it was necessary to define questions and link the disparate elements. This process seems to have resulted in a better understanding of the nature of the subject and manner by which differing elements can lead to particular end results (e.g. the interrelationship of characters in a novel).

The multimedia environment not only provides teachers and students with challenges when gathering evidence to present a particular viewpoint but also, by enabling selective construction, both teachers and students are made more aware of the manner in which the information can be created for the audience.

The different means by which issues can be explored and linked within the multimedia presentation, enables the user to examine a single topic from many different viewpoints by considering multiple texts, encompassing both 'casual visits' as well as structured enquiries. This type of approach is already apparent in the commercial development of multimedia packages such as *The Holy Land*, however, by using software which allows students to create their 'documents' a much wider range of learning opportunities exists. Because multimedia can cater for differing approaches to learning the individual student's learning styles can be accommodated easily.

TEACHING AND LEARNING STRATEGIES IN THE CLASSROOM

A theme which emerged is the emphasis on the changing role of the teacher and the need to 'let the kids go' when they embarked upon gathering and presenting materials. The teacher's role became one of a consultant providing a sympathetic but critical ear listening to the students' problems and suggesting alternative approaches which may or may not lead to a solution. The process becomes a learning path for both teacher and students.

The classroom experience with multimedia indicates that it is vital that teachers and students to not divorce learning strategies, skills and processes which have been developed in other areas and become seduced by the potential of the production possibilities. The multimedia environment favours small group tasks and points to the necessity of building an operational framework so that individual roles can be allocated, responsibilities defined, and planning learning strategies and timeframes specified. It was common to see small groups of students discussing issues and methods of approach; composing, writing and editing materials on screen only after a considerable amount of effort had gone into synthesising relevant materials so that the original purpose would be maintained.

All these operations are highly process oriented and emphasise that good communication skills are essential. These skills are important in combining the elements of the presentation to ensure effective communication. Arguably, however, there is a greater importance in ensuring that each member of the design team is aware of the importance of his or her individual contribution and its relationship to those of the other team members.

While it was necessary to establish overall objectives for a particular area of work to meet the requirements of a syllabus it was seen to be important to allow students to establish specific goals and develop their own means of achieving them. The emphasis within the classroom shifts the teacher into an advisory role, however, this advisory role is often defined more by circumstance than by some preordained set of guidelines. On occasion the teacher has had to reassume their traditional leadership role when it became obvious that projects were

The classroom experience with multimedia indicates that it is vital that teachers and students to not divorce learning strategies, skills and processes which have been developed in other areas and become seduced by the potential of the production possibilities.

floundering, however it was equally important that the teacher did not retain this position for any longer than was necessary while encouraging students to take over the direction of the project.

Paradoxically it was initially apparent that the only way to ensure that some students could develop independence and a sense of direction was to provide that with initially at least a firm sense of direction. To establish this sense of purpose teachers delivered structured lessons which dealt with the key issues (e.g. the development of designs and flow charts to identify specific objectives mapping out students' roles and responsibilities during the project).

Although many multimedia advocates emphasise the many layers existing within a presentation and the high degree of interactivity available, one teacher considered that linear presentation could be just as effective, when explanation of a single concept could be supported by and clarified by a simple demonstration. The necessity of retaining a sense of direction was driven home when on one occasion students exploring a multimedia document became thoroughly 'lost' both within the program and in failing to comprehend the nature of their original task.

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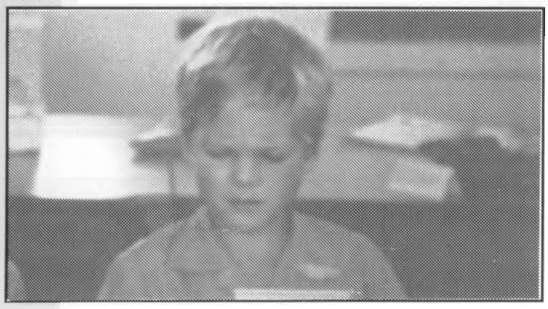

Interactivity therefore often touted as being an indicator of involvement was therefore seen, in certain circumstances, as being more a source of frustration and annoyance distracting from the original intent of the work.

The existence of a number of small groups created pressure on available resources and evidence gathered in the investigation points towards the need to adopt and adapt of already established learning activities which complemented the topics under development. By ensuring that students were productively engaged in learning activities the sense of frustration that could build up as groups 'waited their turn' was reduced. It was also viewed as being important that multimedia is seen as being another, albeit attractive, means of learning rather than be central to the learning process.

In general, multimedia was not seen as being the solution to learning but a valuable addition to the range of strategies and activities which could be incorporated into the classroom learning environment. It was also seen as being a useful stimulant to gifted students as well as being valuable in developing cross-curriculum skills. The very fact that materials could be generated by students and teachers on a small project team also changed the emphasis of between teacher–student. There was also a belief that over time, as experience and expertise grew, suitable materials could become available for use by other students and teachers in a number of curriculum areas.

In essence the learning strategies needed to undertake the development of multimedia were ones which emphasised cooperative learning, improved self-esteem, problem solving, communication skills as well as students defining their own objectives and the means of achieving them. These skills and their accompanying strategies should remind educators that multimedia is being only one component of the learning process.

CURRICULUM IMPLICATIONS OF THE USE OF INTERACTIVE MULTIMEDIA TECHNOLOGY

All teachers interviewed remarked that multimedia as a learning tool had considerable application across the curriculum simply because it was a means of combining a number of stimuli and incorporating a degree of interactivity leading to greater involvement on the part of the student. The combination of this type of software allowed students and teachers to develop a sense of control and direction over their product.

It is important at this point to differentiate between the commercially available products, such as the computer-assisted learning packages which provide the students with a specific range of options, and a central focus which was the exploration of the learning processes undergone when students construct their own presentations.

The teachers perceived the capacity of multimedia in terms of their own particular teaching area, however, experience indicated that this type of program was more important because the skills gained were generalisable. Multimedia can be linked to a teacher's program and, thus indirectly, the philosophy of the curriculum at any point where students and teachers felt that they were applicable.

The trend towards the development of syllabus based upon integration of content and context are the key elements of multimedia.

For example in the recently developed Queensland Department of Education language arts syllabus this view is apparent in a view that:

> Whether composing language ourselves or comprehending the languages used by others, we make meaning through features associated with each of the modes, spoken, written, nonverbal, visual and auditory. (1991, p. 5)

and a subsequent comment:

> In any text, or instance of language use, the meaning is not carried by any one type of mode or feature, but by all types in combination. (1991, p. 5)

We make meaning from texts holistically by combining verbal, non-verbal, visual and auditory components. Meaning therefore is constructed through the combination of language components which are the very heart of multimedia.

This particular Queensland syllabus indicates that English language arts programs should include a balanced range of genres and social contexts, integrate the various modes of language and address a range of complex genres and social contexts. All these components are reflected in the multimedia process.

The position formally stated in this curriculum guide is supported by work undertaken in the United States which emphasises the necessity of overcoming conceptual and organisational barriers which are likely to hamper the exploitation of multimedia as both a teaching and learning tool (Dede 1989, pp. 23–6).

The potential of multimedia to combine communication modes was underlined, both for students and teachers, by the need to develop effective communication skills not only in the traditional areas of text and audio but also in, for several teachers, the relatively new areas of graphics and images. It was in this latter area, analysis, selection and manipulation of images, that the teachers felt that they needed greatest support in order to exploit the potential present in a multimedia environment.

While developing materials for use both students and teachers became aware that the nature of the multimedia environment demanded much more in terms of higher order cognitive skills. It became evident that it was not sufficient to collect enormous amounts of information if the students were unable to sift through the data to develop and support their own ideas while drawing upon skills relevant to several curriculum areas.

TEACHERS' ROLES AND PROFESSIONAL DEVELOPMENT NEEDS

One of the central issues in introducing multimedia, however, is not the questions, the hypotheses or even the roles of the individual teacher and student but the school culture, itself constrained by a second unofficial agenda which operates within each individual classroom. The multimedia agenda, however, requires that teachers and students develop learning methods and styles which may conflict with previous sanctioned methods of inquiry. An indication of the latent power of these previously sanctioned methods was the teachers' discussion of manner in which these agendas were reflected in their initial reluctance to allow this to occur. The initial reluctance also stemmed from the teachers' sense of moral responsibility for their students' education.

The key change in the student–teacher relationship was that which moved away from the directed lesson and the perception of the teachers as the source of knowledge.

Multimedia was found to be a great leveller, in one student's case tapping into a latent talent to think in multidimensional terms when designing presentation. Students also found that because they could negotiate the terms of their work they were placed in a more responsible position which imposed advantages and constraints on the way they 'learned things'. The nature of small group work also meant that teacher and student dealt with each other on more informal terms and the degree of consultation and participation in decision making was higher.

The whole nature of the teacher's basis for providing a sense of control and direction in such a context is an issue of some consequence. The more informal nature when combined with the student's capacity for developing aims and objectives alters the perception of the teacher's role shared by students and teacher by altering the basis on which it has been built as a 'leader' in the classroom.

It became apparent that ongoing professional development programs were essential if multimedia was to be introduced successfully into the classroom.

Though initially requirements from the teachers were for programs which supported the introduction of the technology and associated software, it was recognised that educational and curriculum application were of the greatest long-term significance. Another area of need was knowledge of the existence of additional useful software programs, however, this item was seen as becoming important only after teachers and students had become 'comfortable' with the technology.

It became obvious that in order to exploit the potential of multimedia there also was a longer term need for consultation with other educators to establish a sense of direction for each teacher's program and to encourage cross-fertilisation of ideas.

Despite the diverse needs of teachers there was consensus that a number of meetings over a lengthy period would ensure not only that valid educational programs were established but that sufficient time was provided to enable teachers and students to establish, and achieve, realistic goals. The need to establish regular network meetings was also seen as being important psychologically, helping to remove a sense of isolation as well as establish a sense of continuity for those embarking in this area of education.

CONCLUSION

The introduction of multimedia into the classroom while making an opportunity for further integration of information technology into the curriculum cannot be considered to be a radical departure from the underlying purpose of education. Multimedia will certainly enable students and teachers to develop new skills but much of its effectiveness will rest heavily upon practices and skills such as higher order thinking skills, problemsolving techniques and improved communication skills already established as forming the basis of a relevant and comprehensive education.

An area which will require modification if such an objective is to be achieved is that of the classroom culture. These changes will bring modifications to the teacher–student relationship resulting in a considerable departure from the traditional assumptions about leadership, knowledge and management. It is also evident that multimedia will require ongoing commitment to professional development programs if its promise is to be fulfilled.

Finally, full credit must go to the teachers and students at Noosa District State High School, Ipswich State High School, Mount Marrow State School and Currumbin State School who not only discovered much about the value of multimedia but also struggled through the apparently endless difficulties encountered during these multimedia learning curves.

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DEVISING THE DEVICE:

microcomputer input decisions for young children

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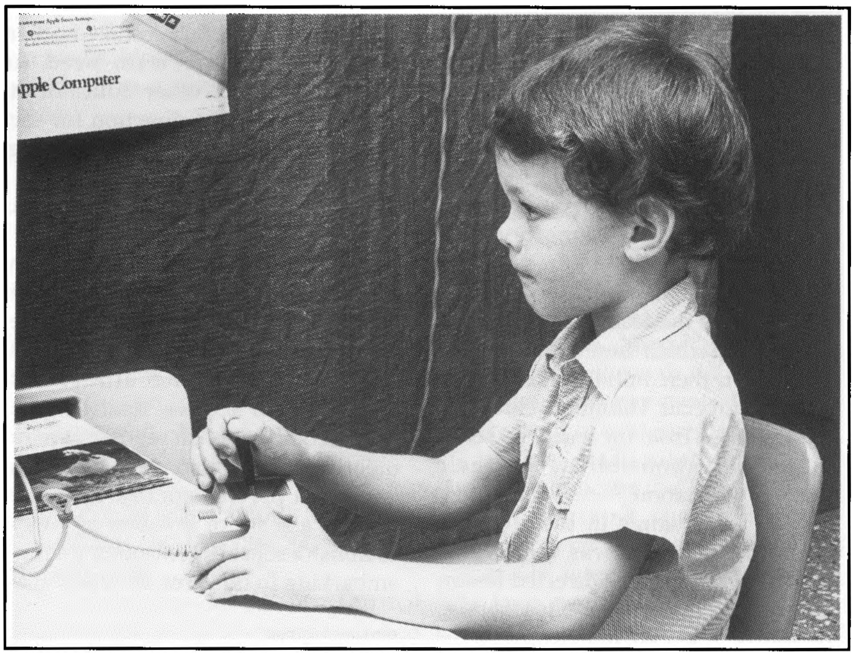
This article reports on research relating to the efficiency of use of the mouse, joystick and keyboard by children from preschool through to grade three. The results indicated an increasing efficiency of use for the task set from keyboard to joystick to mouse for all the grade levels investigated. Efficiency of use improved significantly between preschool and grade one and then levelled off, while the order of efficiency of use of the three devices remained constant across age levels. Preference for particular devices varied according to grade level, with the older two grades showing a clear preference for the mouse, the most efficiently used device. The preschool children preferred the least efficiently used device, namely the keyboard.

John King and Nola Alloway lecture in the School of Education at James Cook University, the former in educational computing and the latter in early childhood education. Their joint research interest is in the effects of microcomputer technology in early childhood settings, with particular reference to the gender construction of young children's choice of computer-related activities.

INTRODUCTION

The use in society of microcomputer input devices has evolved from a somewhat exclusive use of keyboards to one in which, for most purposes, some combination of the mouse and keyboard is used. While this has been a feature of Macintosh computers for a decade, it has only more recently become common for other PCs following the introduction of 'windows' environments. Of late, a further evolution has occurred in the notebook computer market with the introduction of built-in trackballs in one brand.

Upper primary and secondary school students have been provided with microcomputers containing input devices identical to those used in the workplace on the basis of what appears to be two assumptions: firstly, this type of student needs to become proficient in the use of these tools in order to develop work-related skills; and secondly, it is assumed that they possess the motor skills necessary to use them effectively. The question of the suitability of particular input devices for use with young children, however, is more problematic.



Preschool child using the joystick

The input requirements of young children are significantly different from those of older students and adults. The ability of young children to input text, for instance, is severely restricted or non-existent. Hence the requirements for keyboarding can be confined to some combination of the return key, the 'arrow' keys and in some cases, the Space Bar and Escape keys. This has had the effect of marginalising the keyboard as the preferred input device. Also, because extensive use is made of the motivational features of electronic games in programs for this age group, the operation of the software lends itself to the use of games peripherals such as the joystick and mouse, as well as 'iconic' input devices such as the concept keyboard. However, the literature is somewhat divided on the suitability or otherwise of particular devices for young children. On the one hand, we see statements by Clements (1987) claiming that 'Using the standard keyboard is not a problem for young children, and is often superior to other devices such as a joystick' (p. 34); and then statements of the opposite kind such as Blemings's (1988) assertion that the keyboard was designed for adults and for some children contains 'an overwhelming amount of distracting and irrelevant information' (p. 74). Other information has been contained in surveys of such devices as Muppet Learning Keys and photonic wands, as well as Education Department sponsored investigations which have tended to report at the level of observer reflection on children's interaction with the device.

Research evidence on adult usage of input devices has been available for some time and is exemplified by that of Card, English and Burr (1978) who found that continuous movement devices, such as the mouse and joystick, are used more efficiently than key-operated devices. Empirical studies with young children are far less common and more recent. In an investigation of the use of computer-based pointing devices by 6-, 8- and 10-year-old children, Jones (1990) carried out four experiments requiring children to point to and click on screen targets. The children were required to make horizontal, vertical and orthogonal moves with the devices, and were timed for different trials. These experiments provided information on, among other things, the relative efficiency of use by these children of the mouse, joystick and trackball. For the 6-year-olds, the order of efficiency of use in terms of lowest times across all four experiments was: joystick, mouse, trackball. For the 8- and 10-year-olds, the joystick enjoyed five of the eight lowest times, with the mouse taking three.

King and Alloway (in press) found in a study with preschoolers that the mouse was more efficiently used than the joystick which in turn was more efficiently used than the keyboard for the set task which involved selecting, moving and deselecting an icon on the screen. This finding corroborated results for adult samples mentioned previously, in that the continuous movement devices, namely the mouse and joystick outperformed the keyboard for the set task, but differed from Jones's result in relation to the measured order of efficiency of the joystick and mouse. Since the task requirement in the present study involved unrestrained movement of an icon compared to the Jones procedure where the children were required to point and click on targets in specified directions, it seems reasonable to explain the conflicting result for the joystick and mouse in terms of the difference in the task requirements. Jones, however, argues for more research in the area to determine:

> ... which configurations will prove to be the easiest to manipulate, the most efficient to use and the least *demanding on their processing capabilities ... (p. 75)*

The present study extends the scope of investigation of the use of input devices by young children from preschool to grade three. While a number of studies (e.g. Thomas [1980]), have reported an increase in motor performance over time with young children, the paucity of specific research in the use of input devices across different age groups suggested this as an area of useful investigation. Hence this study has focused on the question of whether the efficiency of use of particular input devices varies across grade levels from preschool to grade three and whether the order of efficiency of use of input devices is maintained across these grade levels. It was also of interest to the researchers to further investigate young children's preference for input devices, as this has rarely been undertaken (King & Alloway, in press) and to discover whether gender is a factor contributing to the efficiency of use of input devices. While there is no suggestion in the literature that there are gender differences in motor development in early childhood, data on the relative efficiency of boys' and girls' use of input devices could inform the debate on the gender construction of microcomputer activities.

GRADE	N	MOUSE	JOYSTICK	KEYBOARD
PRESCHOOL	34	19.9	47.2	91.0
1	15	12.8	23.1	52.0
2	15	8.7	15.9	39.9
3	15	9.0	13.7	29.7

Table 1 *Means of efficiency of use of input devices for the performance of a set task as time in seconds*

CONTEXT OF THE STUDY

Students used in the study were drawn from the morning and afternoon sessions of a preschool centre and from a multi-age group of 6- to 8-year-olds at a primary school. The developmental groups of primary students identified, henceforth referred to as grades one, two and three, had average ages of 6.7, 7.8 and 8.5 years which are approximately one year apart. The preschool group were two years younger than the grade one group, with an average age of 4.7 years. This difference resulted from data being collected at the beginning of the year for the preschoolers and at the end of the school year for the other students.

Most of the primary students had some previous experience with a microcomputer as one had been situated in the classroom for the year, although not all students had used it. No input peripherals additional to the keyboard were available. Some preschoolers alleged previous use of computers, but no accurate indication of their experience with specific input devices was possible for this 'difficult to interview' age group.

The software used for the study was *Rosie, The Counting Rabbit* (Learningways 1987). It was chosen on the basis that: it allowed the use of either the keyboard, joystick or mouse; it was considered suitable for the developmental level of the age range involved; and it lacked aggressive and competitive characteristics.

PROCEDURE

Data were collected in the same manner for all children, other than for the time of collection as mentioned previously. Three Apple lle microcomputers were used for data collection, one each for the keyboard, joystick and mouse. Students were given the same practice time for each device using a similar set of tasks for which they were to be tested. At the end of the practice time, they were timed for the set task which involved the selection, movement and deselection of a screen icon. The task was timed for a second trial and the average of the two times used as a measure of the efficiency of use of the device. Students were tested only once in any half-day period and were randomly assigned to the devices.

RESULTS

The efficiency of use data were initially analysed by taking into account gender, grade and device type. As this analysis indicated that gender was not significant as a factor, the final analysis considered only grade and device type and is reported as means in table 1. Statistical tests of significance on the means indicated that the mouse was more efficiently used than the joystick which in turn was more efficiently used than the keyboard across all grades. Statistical tests on the grade level factor indicated that the preschool group differed significantly in efficiency of use for each device type from each of the other three grade levels. The primary grades showed no significant differences among themselves for any input device even though some apparent variation between the means is indicated in table 1. Further tests revealed that both the joystick and keyboard, in comparison with the mouse, were less efficiently used to a greater degree by preschoolers, than by the other three grades.

All children were interviewed after having used all three devices to determine their preference for a device. From the results obtained, it was ascertained the preschoolers generally opted for the device which they used most inefficiently, namely the keyboard. For the grade one children, no distinct pattern was discerned. However, for grades two and three, the general preference was for the mouse, the device they used most efficiently. Inferences will be drawn from this result in the next section.

DISCUSSION

Consideration will firstly be given to the result that, for all grades, the order of increasing efficiency of use of the devices was keyboard, joystick, mouse. That these children found the mouse more efficient to use than the joystick may be explained by the presence of non-orthogonal movements in the task requirement for this study compared to Jones's (1990) study, a point alluded to previously. It may be that the mouse offers a greater facility than the joystick where unrestricted movement is involved because greater control is achieved by moving the whole device in the desired direction, rather than part of it as is the case for the joystick. The reason that these two continuous movement devices offer a greater efficiency of use than the keyboard may relate to the fact that they offer children a direct relationship between the direction of movement of their hand and the intended direction of movement of the screen icon. Speed of hand movement is also directly related to the speed of the icon movement. By contrast, the connection between the anticipated screen movement of an icon and the choice of orthogonal arrow key movements is somewhat more abstract. Also, movement of the icon to the desired location must, of necessity, be non-diagonal or 'ladder-like' and hence involves a longer trajectory.

While the results indicate that the preschool group operated with a significantly lower level of efficiency in relation to employment of all devices than the group of primary children, no such significant differences were found between grades one, two and three children. This suggests a developmental discontinuity in motor skill proficiency between preschool and early primary grades. It needs to be recalled, however, that in this study, the age gap between the preschool and grade one sample was two years because of the difference in time of year of data collection.

The fact that most primary children had some keyboarding experience during the data collection year clouds the interpretation of the result in terms of enhanced motor proficiency and may suggest a practice effect. That the primary students also significantly outperformed the preschoolers using the joystick and mouse without organised prior experience, lends credence to the claim for greater motor proficiency in the primary group and a marked developmental progression in the two-year gap between the preschool and grade one group.

The lack of a significant effect for gender when initially included as a factor in the analysis of the extended age range data supports previous results for preschoolers alone reported by Alloway and King (1991). This clearly indicates that girls and boys in all grades used in this study were equally efficient at manipulating all the devices in order to complete the set task. While not central to the study, this result is useful in interpreting findings made elsewhere which suggest that young boys access and participate in computer activities to a greater extent than girls. Lack of performance differences in computing activities lends weight to a social, rather than a biological interpretation of access and participation differences.

In terms of expressed preference for a particular input device, it seems that the younger the child, the less clear was the association between preferred option and ease of use of the devices. In fact, most of the preschoolers who expressed a preference chose the device that they employed least efficiently. Preschoolers seem to form a more intimate association between the keyboard and computer than older groups. The keyboard's greater exploratory potential may also have been a decisive factor in their preference for it over the less elaborate devices. This is evidenced by the need to cover the keyboards of the machines containing the mouse and joystick during the experiment to stop the preschoolers regressing to the keyboard. For the grade one sample, no clear pattern of preference for a device emerged, with children choosing a particular device for reasons that bore no particular relationship to ease of use. However, grade two and three children chose the device which empowered them to carry out the set task most efficiently. This suggests an increased concentration on task accomplishment rather than play for these two oldest groups.

CONCLUSIONS

This study clearly demonstrates that boys and girls from preschool through to grade three experience the same order of efficiency of use of the input devices investigated. It also reveals that the efficiency of use of all devices increases with age. Results suggest that not all children will be attracted to a particular device on the basis of ease of use; the younger the child, the more likely it is that the least efficient device will be preferred. Preschool children appear to view the keyboard as an integral part of the computer, rich in exploratory possibilities and to be preferred to the exclusion of the more efficient devices. Whether a detachable keyboard, as distinct from the built-in keyboards used in this study, would retain the same fascination remains unknown.

Teachers need to be aware of the above differences in planning computer experiences and should consider the aims of the activity when making a choice of the input devices available. Also of interest to teachers is the finding that by the end of grade one children can use input devices with a proficiency equal to that of children two years their senior. These older grades can be viewed as a single group in this respect. Finally, armed with the knowledge that girls display equal competence in using input devices, teachers must challenge the construction of computer activities as male when faced with access and participation rates favouring boys.

As the proliferation of alternative input devices into educational settings continues, additional research which goes beyond the level of observer reflection will be necessary to help teachers ensure that all children are given appropriate opportunities to

continued from page 20

interact, at their level of development, with the electronic tools that are now so persuasive in everyday life.

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From the Classroom

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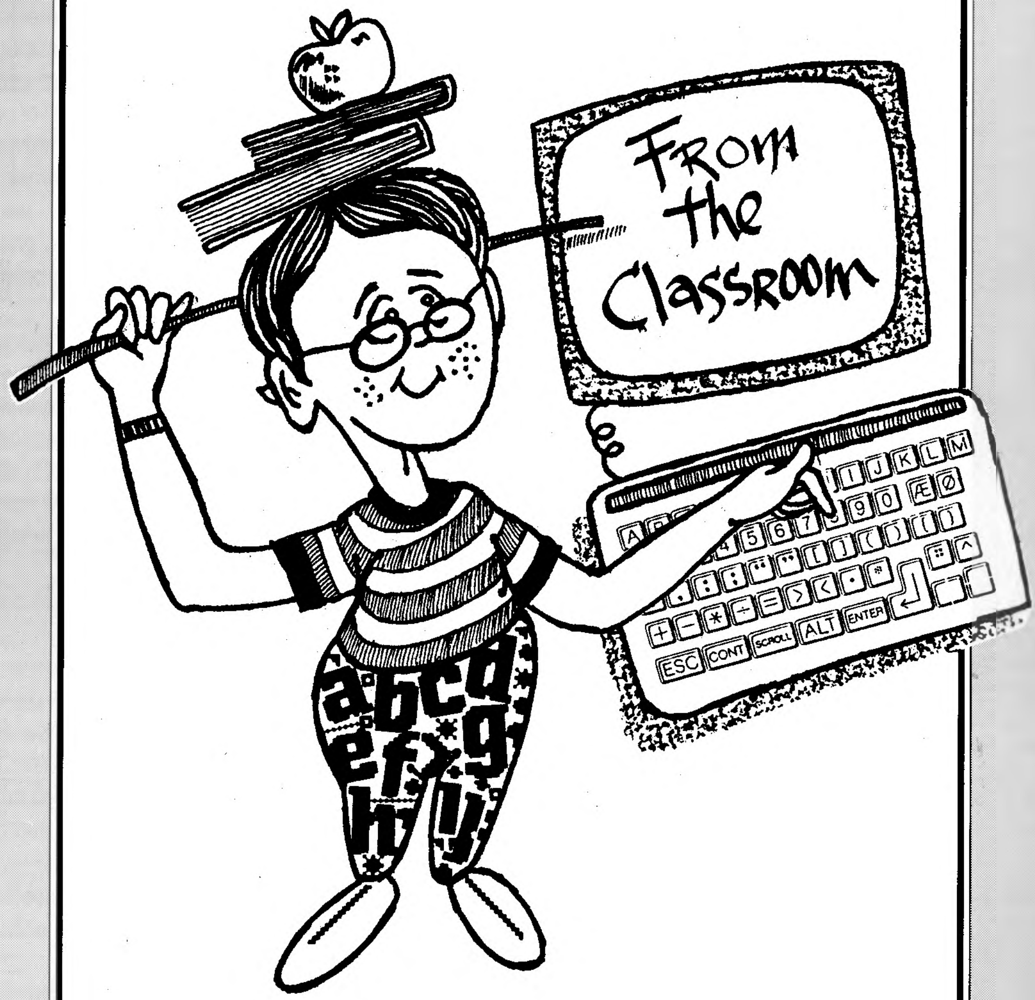

COMPUTER IMAGING FOR ALL STUDENTS:

implications for whole-brain learning

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The authors of this article in forming this research and writing collegiate have come to their appreciation and enthusiasm for computers as whole-brain learning tools from two differing perspectives — one as an art teacher who initially approached the medium as a new and exciting tool, the other with a passion for helping all children to learn. TAFE programs enhance opportunities for our students at upper high school levels and the task sheets included in this article make the content of the syllabus accessible for students in the classroom. The research into learning styles in a graphic computer environment with a select group of TAFE students illustrates the flexibility of the computer as a tool for encouraging whole brain learning.

INTRODUCTION

Computer imaging is seen as another area in which art students can extend their creativity by harnessing modern technology to produce exciting new products. However, what happens when holistic, creative learners need to acquire sequential, analytic skill before they can work in this medium in a creative way? What happens when the logical computer buff sees this as a further chance to learn more about computers? How do these diverse thinkers cope with the requirements of computer imaging that needs the logical applications of the analytical thinker as well as the creative awareness of the artist? This study looks at responses from students who cover this range of learning styles, to such a course conducted by a secondary school Art and Technology Centre. Further work throughout the year will look to redress the difficulties some students have experienced when trying to function in an unfamiliar learning style.

THE SETTING

The Art and Technology Centre has been operating since 1989 and now contains: Amiga computers, video cameras, a postscript printer, a colour printer and an audio digitiser. This range of hardware is supported by a large range of software from painting and drawing programs, desktop publishing and video presentation programs.

The Centre functions as an interactive facility and, although situated with other art rooms, it does remain separate and secured. The equipment it contains has the capacity to generate artwork, extend art practice and problem solve in an endless combination of possibilities. Images can be developed on an Amiga by using it as a drawing, painting or animating tool and artwork is often extended by working (through design processes). The final products can be printed in colour or black and white, as a transparency, colour print or slide, on videotape or saved to disk. These facilities are used by art students of all year levels from 8–12, artwork students in Years 11 and 12 and students taking the TAFE course in Computer Imaging and Desktop Publishing. Other interested students, outside organisations and local businesses also access the Centre. It is in enormous demand and generates a great amount of interest and enthusiasm in the users. Consequently, it is a continuing concern to stimulate creative practice and maintain a cutting edge approach to technology.

THE PROGRAM

Small groups of students who access the facility for a limited time of one and a half hours each week to take the TAFE modules in Computer Imaging and Desktop Publishing written by Peter Wharton, lecturer in Graphic Design at the Queensland College of Art, Griffith University. It was the teacher's decision to offer the course to all students who need not necessarily be undertaking a program of study in art or artwork. To broaden all students' opportunities in visual art and design there has been no attempt to cull or deliberately select students for this course. The only encouragement has been to canvass for a balance of girls and boys on an equity of access basis.

This open access created a set of circumstances and problems that had to be addressed. How these were addressed provided much of the material for this article and much provocative discussion for the writers.

In keeping with the aims of the Centre, the program was designed to provide opportunities in art education for all students, to extend the use of the facility and to foster creative practice. It was also hoped to encourage mathematics/science students who are often afraid, disdainful or sceptical of the visual.

The course is organised to cover and satisfy the requirements of TAFE but also nurture and expand the creative visions of 18 individuals to a greater or lesser degree. Task sheets have been written to clarify the content of the syllabus, to sequence development of skills and knowledge, to force the issue to work in a problem solving manner and finally resolve a task by producing an image, animation or video. This sample (figure 1) is one of the early task sheets.

TASKSHEET 2: INTRODUCTION TO COMPUTER IMAGING

Hardware: Amiga computer with minimum of 1 megabyte of memory
Software: DeluxePaint IV
Content: Customising brushes
- creating a brush
- selecting complex shapes
- removing objects from the background
- saving the load brushes
- handle
- perspective

Task: Create an imaginative image which demonstrates your knowledge and understanding of customised brushes using the software program DeluxePaint IV.

Procedure: Demonstration of processes by teacher. Experimentation using support material and/or manual. Production of your image during this session or with subsequent lunch time sessions.

Support Materials:

CREATING A BRUSH

Select a custom brush tool using left mouse button. Background colour will be transparent and you duplicate the selected section. By picking up a custom brush with right mouse button you remove the selected section leaving the background colour. Create an irregular shaped brush by double clicking on the brush selector. Complete the shape by pressing the space bar. Using the Autotransparency option allows you to change the transparent colours in your brush. The same colour clicked on when creating a polygon brush will also be transparent if autotransparency is turned on.

REMOVING OBJECTS FROM THE BACKGROUND

Refer to the above points in creating a brush but do not check your active background colour as your customised brush treats it as transparent.

SAVING AND LOADING BRUSHES

Brushes can be treated just like pictures. They even have their own menu. Brushes can be loaded and saved just as pictures can. Brushes when loaded come equipped with their own palettes. If the current picture has a palette different to the brush palette, the palette can be changed by:
Change Colour > Use Brush Palette (Picture Menu).
If you want to use newly loaded brush with current palette use
Change Colour > Remap (Brush Menu)

OTHER ITEMS IN BRUSH MENU

Allow you to resize, reshape and recolour brushes in various way

HANDLE

Is an option used with more advanced persons with this program. It allows you to specify whother your arrow cursor sits at the centre (Default Setting) or at one of the corners of the brush (used with Perspective in the Effects Menu). Accessing the corner of the customised brush from the Handle Submenu moves the cursor to lower right hand corner of the brush. Further accessing moves the cursor from corner to corner.

PERSPECTIVE

Perspective accessed through the Effects Menu lets you rotate a brush through any of three axes of 3D space to define a plane of operation.

FAST FB

This option can be selected from the Prefs menu and redraws all parts of a brush with single pencil lines instead of showing the full custom brush until drawing is finished.

CHANGING PAGES

Auseful item when manipulating brushes. This enables you to swap from page to page.
Spare > Swap (Picture Menu) or J key.
You can have different background colours on each page. Palette follows from one page to another.

Figure 1

THE STUDY

Research over decades has indicated that the two hemispheres of the brain tend to specialise in different functions, process information in different ways and handle different problems. In most individuals the left hemisphere specialises in logic, words, facts, step-by-step thinking, symbols, organisation, and time. The right hemisphere specialises in intuition, pictures, emotions, synthesising, creativity and is time free. Both sides of the brain are used but one side is usually more dominant and this is often used, even if inappropriate to the task. Developing the less dominant side would allow an individual to use the most effective mode of processing for a task, he or she would be using the whole brain.

The school has been involved in addressing this problem and in promoting whole-brain learning, based on Herrmann's (1989) whole-brain model of thinking, learning and acting. He attributes different processing styles to each hemisphere; the right hemisphere is intuitive and holistic, and the left hemisphere is analytical and sequential. However, in this model each hemisphere has within it two levels of thinking, the cerebral mode that is rational, conceptual and reflective, and the limbic mode that is more emotional and doing. This results in a four section model of whole-brain functioning (figure 2).

All staff were inserviced in the main features of the theory and some applications suitable for the classroom. Some staff looked in more depth at strategies that would assist those students who were predominantly either logical or intuitive learners. The students who elected to do TAFE Computer Imaging Course were from all subject areas in the school and many of them take a highly scientific and mathematical course of study with a greater likelihood of being logical, sequential thinkers. There is little cohesion in the group except for an interest in image making on computers. The logical thinker prefers limited choices and singular outcomes and staff examined strategies that could expand the ability of those students to tackle problems in a more creative, divergent manner. They are a diverse lot in behaviour, knowledge, skills, thinking styles, abilities and sensibilities.

This study investigated the learning and thinking styles of these students. Its concerns were: whether the right-brained, holistic thinkers are

WHOLE BRAIN MODEL

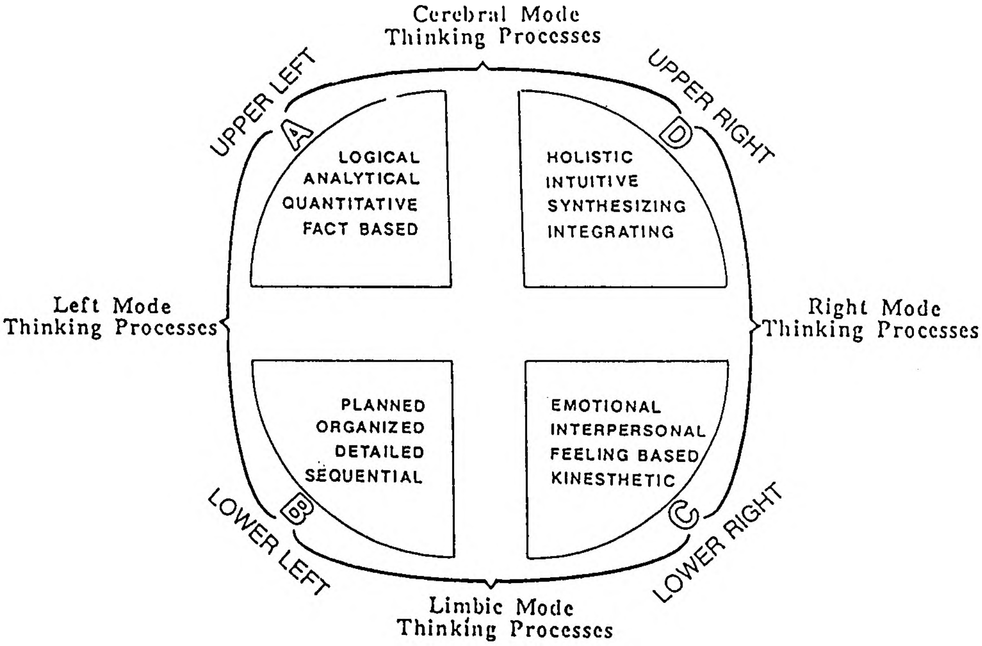

Figure 2 *Hermann: 'The Creative Brain'*

hampered by the sequential, structured use of the technology and are thus less able to be creative; whether the left-brained logical thinkers were able to move from using the technology for its own sake to using it creatively; and, whether any cultural or gender differences discriminated against full participation in the course. To this end research has involved observation of the students' approach to the course and of their facility in using the technology to achieve a creative outcome. They have been tested using a modified version of Herrmann's Thinking Styles Dichotomy Exercise which graphs brain dominance patterns.

A cross-section of three students favouring the right-brain mode, three the left and three comfortably working in both modes was selected for further study. This group was closely observed, interviewed and their subject selection and performance noted.

OUR OBSERVATIONS

Those students with a preference for upper-right-thinking processes coped well with the technology and have found the work fun. They do not seem constrained by the tasks set, or necessarily feel obliged to do them and they are happy with the organisation of the class environment. School subjects they are studying include Artwork (a school subject) and Mathematics in Society amongst a range of others but do not include the traditional 'maths–science' subjects

The student from the 'lower-right' group has a 'maths–science' background and high task commitment. Here the experimental nature of the upper-right mode students was missing and this student experienced difficulty creating the image that was initially visualised. The frustration felt in not achieving at the usual high level was evident in her reporting the class environment only moderately satisfying.

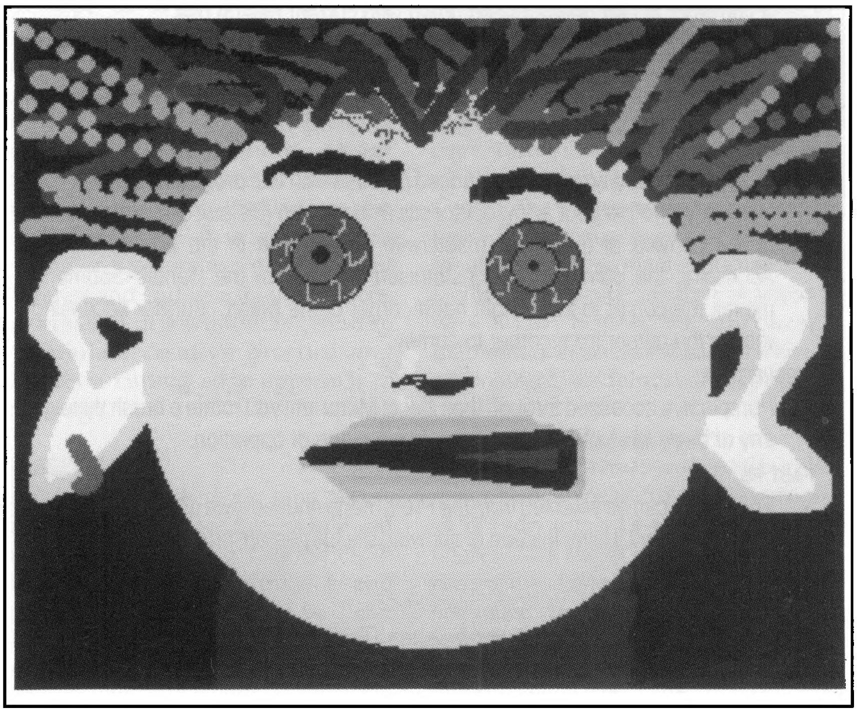

Figure 3

Where the preferred mode of thinking was fairly evenly balanced between right and left hemispheres, students were comfortable with the technology and the processes. They were quite happy with most aspects of the class environment but the concern with inability to 'think of anything to draw' started to appear. Such processes as digitising images which they could then rework and extend helped these students. The school subjects they had selected to study tended to contain unusual combinations such as Home Economics and Mathematics 1.

In the group with a left mode of thinking the students exhibited characteristics of both the upper and lower quadrants. Here, however, there was a marked difference between the males and female. The males were interested in the technology and felt that they were already familiar with it. However, they found the lack of a set goal difficult initially because they could not visualise images that they would like to produce. The female was able to use the technology to develop creative images and enjoyed extending imported images.

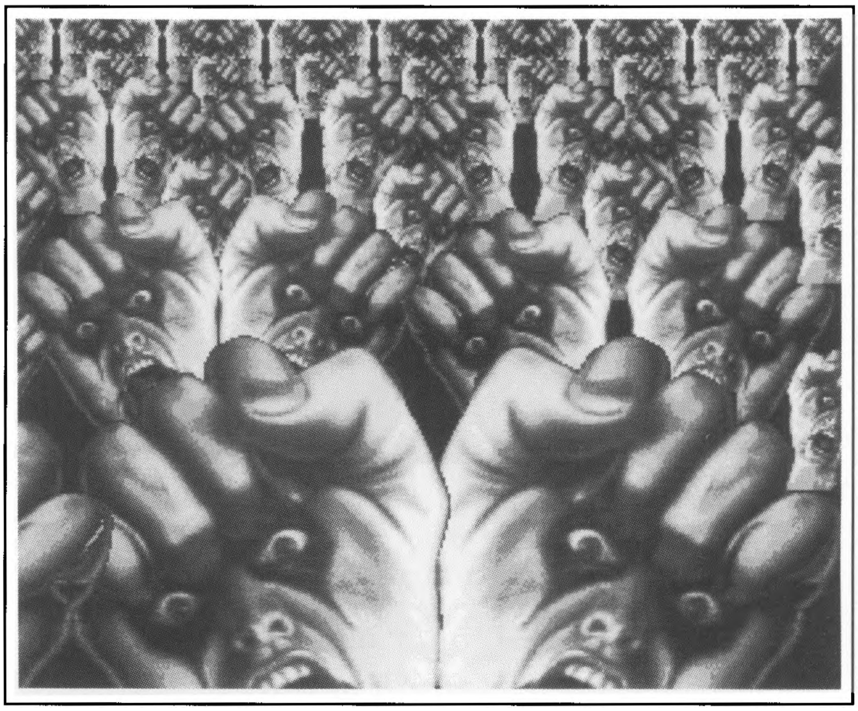

Figure 4

DISCUSSION

A key observation of this study was that none of these groups of students has found the technology daunting. The barriers they have experienced have not been the technology, they have been the creative demands of the course. The right-brained students did not require excessive assistance to use the technology, however, they actively sought teacher support when they were in need of it. With each new aspect of the technology to which they were introduced they took what they wanted to know *at the time* and applied it to solve their own problems. They came with their own ideas which they wanted to try and did not look to others to provide the inspiration for their work. The upper-right mode students liked creating, inventing and manipulating the equipment rather than being especially concerned with finishing a task. They were openly enthusiastic whereas the other right-brained student displayed a much quieter approach.

The work that these students have produced to date demonstrates the Centre's capacity to extend learning and promote creative practice. The creativity unleashed by this medium is overwhelmingly apparent in these examples of one right-brained student's work on the same theme, one from the first session (figure 3) and the other three months later (figure 4).

The students who experienced most frustration with the course were male left-brained thinkers. They required more direction, more specific instructions and needed fixed outcomes without which they felt most uncomfortable. While the other groups had ideas with which they wanted to experiment these students maintained that they did not have internalised ideas of their own to try. This was because they did not visualise, they had no pictures in their heads.

This frustration became more explicit on examining the student interviews and profiling. Subsequently, strategies were set up to encourage these students to make the breakthrough in

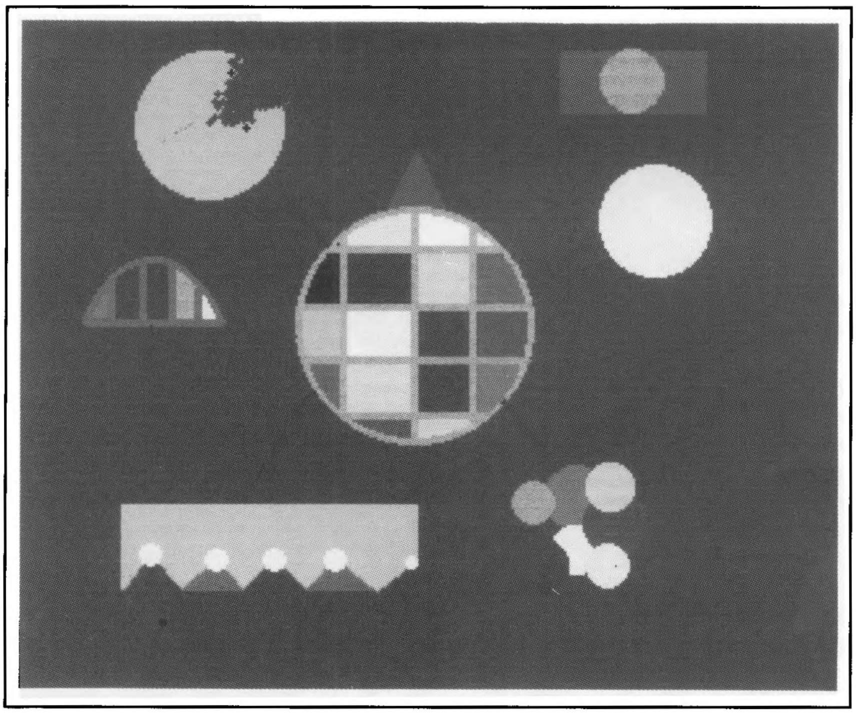

Figure 5

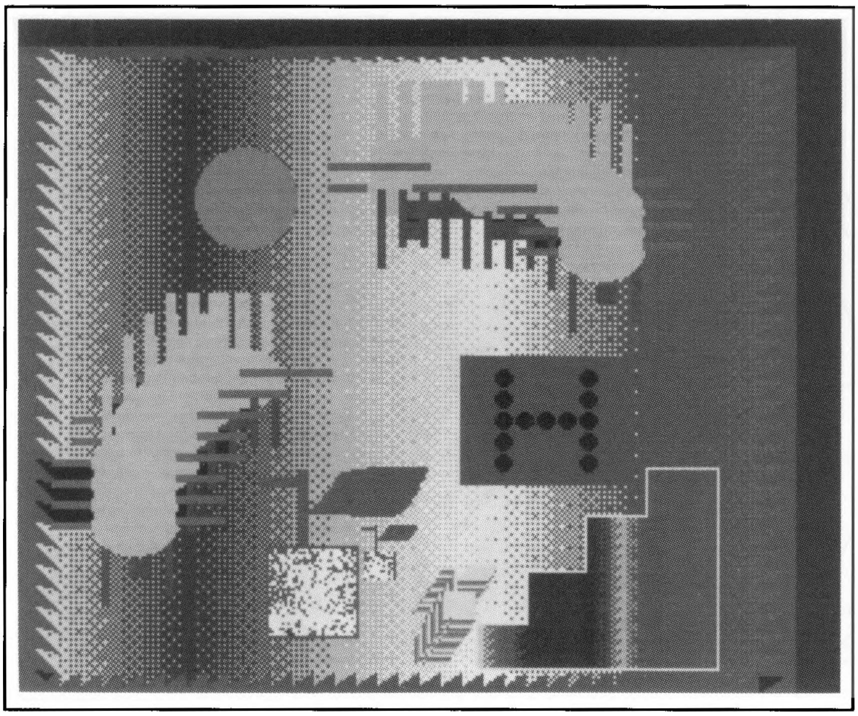

Figure 6

creativity. They were encouraged to move out of their preferred mode of thinking and work to accept the legitimacy of risk taking. These images (figures 5–7) illustrate the huge strides these students made once they were prepared to step out of the known, they show a development in creativity.

What has become apparent is that, as the course progresses, images created by all of the students have become more complex and the approaches taken to create them have become similar. All of the students have gained significant knowledge of design problem solving, no matter what their preferred mode of learning.

The frustrations still continue but a feeling of enthusiasm permeates the Centre as the students work quietly and collegially on their recent tasks.

CONCLUSION

The course has addressed teaching and learning practices that we are trying to encourage so that our students will be prepared for the life-long learning that faces them. Some of these practices include:

- designing
- problem solving and critical thinking skills
- self-paced and autonomous learning
- peer tutoring
- creative practice
- enterprise
- the need in everyone to find avenues of self expression
- looking at, evaluating and responding to our world
- familiarity with technology.

The research has been catalytic in bringing added flexibility to the program to cater for the diverse needs of the group. Assessment can now take place once each task is completed or at an appropriate time elected by individual students, or at the end of the course, with the student selecting the method of presentation. Negotiation and collaboration are important aspects of the student/teacher interactions and students' awareness of this perhaps unfamiliar aspect of the learning environment has been made more explicit. It is rarely a teacher-dominated environment and, although a very busy one, it is a quiet place where students and teachers enjoy sharing and exchanging information and ideas.

The teacher, in the role of facilitator, looks for the key to every individual's creativity, to unleash new ways of looking at our world and responding to it. For some this may be as easy as turning within and exploring the ideas in their minds. For those and for others it may come from their visual world in a number of ways:

- looking at it
- drawing it
- talking about it
- from books
- from video and film
- from other artists
- from music
- from the technology itself.

Visiting artists and tutors have a most significant role to play in unlocking creativity in this program.

The task sheets fulfil an organisational need for the teacher to cover TAFE requirements and for those many left-brain dominated students

continued on page 40

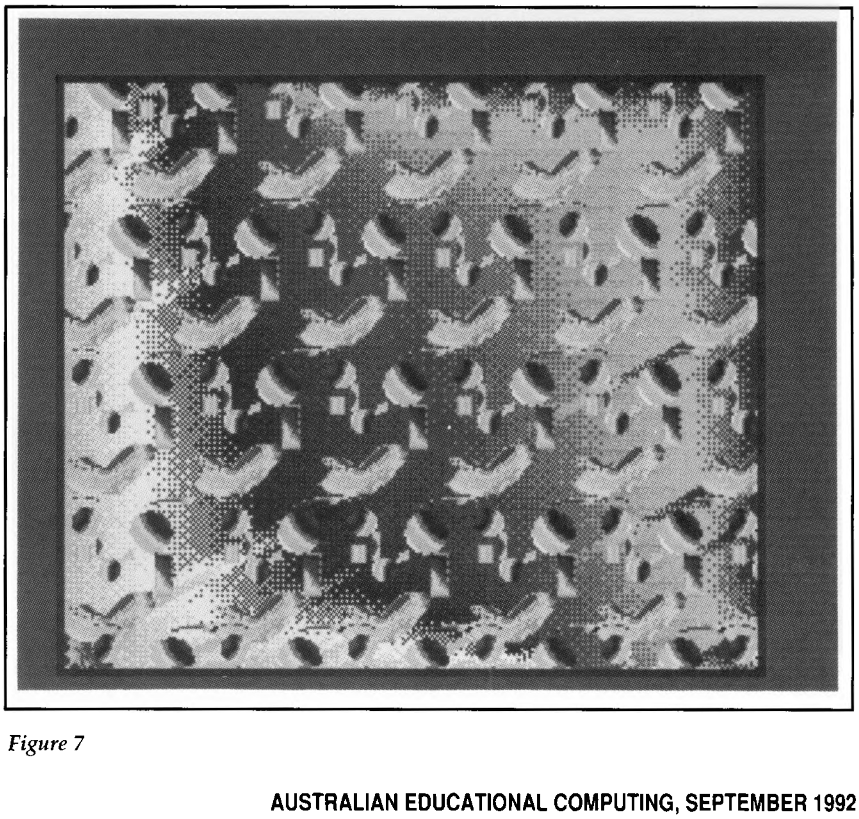

Figure 7

AN INVESTIGATION OF THE EFFECTS OF COMPUTER INSTRUCTIONAL GAMES ON STUDENT LEARNING ☛ ☛ ☛ ☛ ☛ ☛ ☛

Computer educators, in evaluating the various educational applications of computers, are increasingly focussing their attention on applications other than tutorial or drill and practice. In particular, games are being judged to be of potential benefit to student learning. Scriven (1987), for example, has analysed the potential of games for learning processes in a paper entitled 'Taking games seriously'.

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THE CONTEXT

Games and learning

The potential of games for learning purposes has been suggested for a long time. For example, Henson (1982) reported an account of the 19th century school teacher, Maria Montessori, who devised educational games for her pupils, basing such games on her pupils' natural environment and behaviour. Such 'natural' forms of education are reflected in the words of educators, for example Dewey (cited in Boocock & Schild 1968), who believed that children (or learners) should be directly involve in their learning.

This interest in the use of games in schools has gained impetus from the availability of computers in schools and from the large numbers of computer games that have been commercially produced.

With the increased popularity and usage of computer game software in schools, the benefits of these games on student learning has been questioned. Chaffin, Maxwell and Thomson (1982) have claimed that in comparison to other teaching methods, computer courseware which utilises gaming procedures and format is highly effective in instructing students, particularly those with low learning abilities. On the other hand, Lipsitz (1983) has argued that computer games are a commercial enterprise which have as their main aim profit-making rather than promoting an effective or innovative method for teaching students.

Do students truly learn from games? If so, what are the advantages of gaming when compared to traditional teaching methods?

Purpose

The purpose of this study is to explore some of the claims that have been made about games, particularly those relating to the use of computer games in schools. The concern of this study is the use of games as mediums of instruction: Do students truly learn from games? If so, what are the advantages of gaming when compared to traditional teaching methods?

These are complex questions. Any measure of student gain in learning through gaming is dependent on the types of games, the learning environment and, the student's ability level. To evaluate the effectiveness of games (particularly computer games) as mediums for instruction, three types of games with different educational purposes and two types of gaming environments were used.

The games

The reason for selecting three different games only is twofold. Firstly, in order to evaluate the effectiveness of games on students learning it seems essential to consider several games with different educational purposes. For example, the three games that were used in this study *Concentration*, *Yacht Race* and *Number Facts* have, respectively, the following educational purposes: development and enhancement of concentration skills; learning specific content knowledge through simulation; and, drill-and-practice of arithmetic facts. The second reason for the selection of these games relates to a number of constraints in the study, including the availability of resources (for example, computers and games) and suitability for students' ability level.

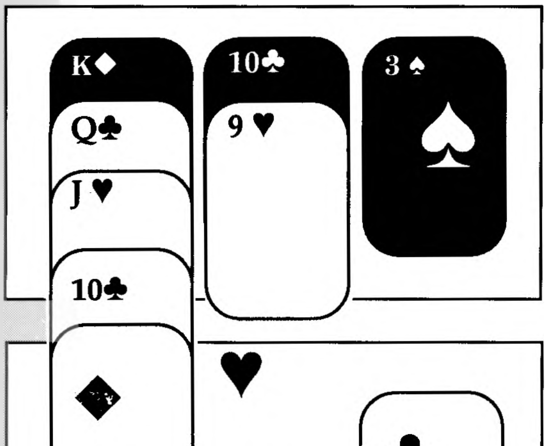
An important part of this evaluation is the provision of two types of gaming environments, one in which the game participants (students) were required to play a game using the computer and the other where the students played a non-computer version (for example, with cards) of a similar game. The purpose of having these two gaming environments (computer and non-computer) was to examine which of the two would provide a gaming environment that is conducive to the learning of the specified objectives of the games.

The third variable in this study, the student, is obviously a vital part of this evaluation. The nine students who participated in the study were identified by the school's guidance officer as special education students (that is, students with low learning abilities) and were therefore placed into a class separate from the usual class streams. Chaffin et al. (1982) have claimed that computer gaming procedures are effective in motivating students with low learning abilities to want to learn.

Types of computer games

Computer games for classroom use have sometimes been classified into two categories: arcade and non-arcade educational games; see Scriven (1987) for a more detailed taxonomy. Although significant claims have been made regarding motivational benefits of videogame formats and procedures to student learning, there is very little evidence available on the effectiveness of such formats in producing substantially better forms of learning than other, more conventional types of teaching strategies.

Non-arcade classroom computer games are commonly used in schools and teachers tend to encourage their students to use non-arcade games in preference to arcade-type games. In this study, three non-arcade games were used: a strategic game (*Concentration*), a simulation game (*Yacht Race*), and a drill-and-practice game (*Number Facts*).



METHODS AND PROCEDURES

The students and their teacher

The participants chosen were nine (low ability of special education) Grade 9 and 10 students (two females and seven males) and their class teacher. The class teacher was a qualified special education teacher who was responsible for the major teaching program for these students.

The purpose for involving the class teacher in the study was twofold. Firstly, classroom teachers should by fully involved and completely aware of any studies which involve their students. Secondly, the times set aside for the study were not sufficient to determine the success or the validity of the outcome for this study. In addition, it was hoped that the results of the study would be incorporated into these students' learning program after the study was completed. For these reasons, it was most desirable for the classroom teacher to be fully involved in the study.

The class teacher, at the completion of the study reported here, continued the weekly two by 50-minute periods of allowing the students to develop skills, practice number and word skills, learn concepts, and develop and practice hand and eye coordination through playing educational computer games. Thus, educational computer games have become an important part of the learning program for the nine students who participated in this study, even after the formal study was completed.

Data collection

Data on student responses to the three gaming activities were collected using comprehension activities, group discussions, and observations. Data on the class teacher responses to the gaming activities and to the students' performance and behaviour were collected using interviews and observations of the teacher's interactions with the students.

Observational data of student responses and teacher interviews were noted in written form by the first author. Although this type of written observation may be considered to have limitations, instruments such as tape-recorders may influence the participants to make responses which are unrelated to the study. Also, the use of additional instruments in the study environment was avoided in order to exclude responses (from the participants) which are not specifically the result of the influence of the game equipments (computer and non-computer equipment).

Some of the data were gathered by the class teacher, who assisted in recording the students' verbal and non-verbal responses (both during the gaming activities and during normal class periods).

The purpose of the comprehension activities was to examine whether the students have understood the objectives of the games they played. Also, these activities would provide additional information relating to the effectiveness of these non-arcade educational computer games to student learning.

Game organisation

The nine student participants were randomly placed into two groups. Group 1 students played the computer versions first and Group 2 the non-computer versions. Both groups were situated in the same classroom.

Observation and supervision of Group 1 was carried out by the class teacher while Group 2 was observed and supervised by the first author. The groups were interchanged after the 'comprehension activity' for each game.

Prior to the implementation of the games, all nine student participants and their class teacher were given a demonstration on how to operate the computer. They were shown how to start the machines and how to load the software. The students were also tested on keyboard skills.

Students were not withdrawn from their normal class activities. Furthermore, the students were under the impression that the researcher was an extra teacher to assist their class teacher.

Study procedures

The study began on the first week of the second term of school and it continued throughout the whole term. The participants in the study were only accessible for one, 50-minute period a week. Also, only one computer was usually available; more rarely, two were available.

As indicated earlier, the students were randomly placed into two gaming groups. Initially, Group 1 played the computer version and Group 2 the non-computer version of the same game. After every two 50-minute sessions with each game, the students were given a comprehension test based on the aims and objectives of the game. In the study-session after each comprehension activity, the groups were interchanged so that all students would have the opportunity to play the computer version. Interchanging the groups also allowed the researcher to make observations of student responses to the two gaming environments (computer and non-computer environments).

With the *Number Facts* computer game, only two students were selected

WEEK	GROUP 1	GROUP 2	OBSERVATIONS
1	General observations of student participants in their normal classroom environment		
2–3	Played *Concentration* (computer)	Played *Concentration* (non-computer)	Students behavioural and verbal responses
4	Comprehension activity on the *Concentration* game		
5–6	Played *Concentration* (non-computer)	Played *Concentration* (computer)	Students behavioural responses to the 'delivery medium'
7–8	Played *Yacht Race* (non-computer)	Played *Yacht Race* (non-computer)	Student behavioural and verbal responses
9	Comprehension activity on the *Yacht Race* game		
10–11	Played *Yacht Race* (non-computer)	Played *Yacht Race* (computer)	Student behavioural and verbal responses
12	Arithmetic Skills Worksheets (pretest)		
13	Two students played *Number Facts* on the computer		Students verbal and non-verbal responses
14	Arithmetic Skills Worksheets (post-test)		

Table 1 *Outline of study procedurees*

to participate because only two computers were available for use in the study. Also, *Number Facts* was designed for one person playing at any one time. In addition, only two students could adequately be observed at any one time.

Table 1 gives a summary outline of the study procedures.

Games

One of the games was *Concentration*, a strategic non-arcade educational computer game. It consists of the numbers one to 60 and pictures in matching pairs: behind each number is a picture (fifteen different pictures in all). If the two numbers chosen reveal identical pictures, the player receives a score, and the two numbers are deleted from the screen. The player with the highest score wins. The non-computer version of the game uses 60 cards with five geometric patterns and numbers one to 12.

The next game was the *Yacht Race*, a simulation non-arcade computer game. Two individuals or two teams can compete. Participants role play a yacht skipper and/or crew member. This simulation game is designed to help students to estimate scaled distances and to read and calculate compass bearings. A non-computer version of this game was constructed for this study. The board design was based on the screen display of the computer version.

The final game was *Number Facts*, a drill-and-practice non–arcade game which was specifically designed to revise the four arithmetic operations with whole numbers. From the choices provided, players in this study chose to revise all the operations except division; the 'easy' level of difficulty; ten questions from each set; expression in one or two digits; and, two of four trials in each. Answers were recorded on paper; correct responses were given when all ten questions have been attempted. A non-computer version of this game was based on four worksheets, each with 100 numerical expressions of a specific operation.

RESULTS

Concentration

A comprehension activity was used to determine whether students had understood the game's objective and to observe the recording/memorising activities of students. The activity involved 60 flashcards.

The cards in each pack were individually displayed for approximately nine seconds each. The students' task was to observe each card as it was 'flashed' and endeavour to recognise any identical recurring card, hence a 'match' can be recorded. Since the value of the 'matched' cards was recorded as the score, this was a motivation for the students to observe closely the cards as they were being presented.

The results of the comprehension activity tended to support the speculation that students who record their observations using numbers and diagrams would score higher on the activity. However, the results indicated little support for the speculation that students who participated in the computer version gain higher scores on the comprehension activity.

The game environment (computer and non-computer) appears to have had little influence on the students' understanding of the game, since there were participants from both environments who recorded their observations using numbers and diagrams and who also had well-organised records and achieved high scores. However, it was noted that students in the non-computer version who scored highly and had used numbers and diagrams were those who had taken more interest in the game activity.

In general, the results of the comprehension activity showed that students who used diagrams and numbers and who had well-organised records of their observations obtained higher scores. It is interesting to note that the class teacher initially recorded her observations using words and numbers. However, she changed her method of recording from the writing of words to sketching diagrams. This she found to be much quicker.

Yacht Race

The comprehension activity for the *Yacht Race* game was in the form of a test. This test consists of five questions relating to the game's objective. Question 1 tests understanding of compass directions: N, S, E, and W. Question 2 tests understanding of compass directions: NE, NW, SE, and SW. Question 3 tests understanding of scaled distances. Question 4 tests understanding of compass direction and scaled distances. Question 5 tests understanding of map reading and direction.

Each of the nine student participants was given a test sheet to complete. However, only eight test-sheets were examined (those of the eight students who participated in the *Yacht Race* game).

The five questions on the test sheet were assigned with possible scores of 4, 4, 5, 4 and 8 respectively, making up the maximum score of 25.

When the students' performances are considered in groups (computer and non-computer), their overall results are very similar. This implies that both gaming environments (computer and non-computer) provided similar opportunities for the students to learn the game objective. The students from both environments achieved high scores on all the questions except Question 3.

This may be because Question 3 required a degree of abstract thinking. That is, the students were required to work out the solutions without the use of concrete aids such as rulers (which were permitted to be used during the gaming sessions). It appears that extra practice is needed in this area before these students can confidently and successfully complete this type of question.

> *The strategic game (*Concentration*) provided a situation for the students to analyse a task and act in a manner consistent with prescribed rules and procedures.*

> *The simulation game (*Yacht Race*) provided a situation for the students to assume different roles. Finally, the drill-and-practice game (*Number Facts*) provided a situation for the students to test their knowledge on arithmetic facts.*

Number Facts

A pre-test and a post-test was given to all of the nine participating students. Since time-on-task is an important variable with respect to the number of correct responses, it seemed appropriate to have a base-line measure (pre-test) and a comparative measure (post-test). The treatment activity was the computer version of *Number Facts*.

The two students answered 40 questions from each of the selected items in the *Number Facts* game: addition, subtraction and multiplication. Each question was displayed for 4 seconds (a total of 2 minutes 40 seconds for the 40 questions). Both students scored more highly on the post-test than the pre-test.

SUMMARY

The report on the three non-arcade computer games examined in this study has shown that each of the three types of games (strategic, simulation, and drill-and-practice) provided different learning opportunities and benefits for the students.

The strategic game (*Concentration*) provided a situation for the students to analyse a task and act in a manner consistent with prescribed rules and procedures. The simulation game (*Yacht Race*) provided a situation for the students to assume different roles. Finally, the drill-and-practice game (*Number Facts*) provided a situation for the students to test their knowledge on arithmetic facts.

The benefits of these games to the students appear to vary according to the game environment. Firstly, the computer version of the strategic game provided an environment that was less distracting for the students than the non-computer version. Secondly, the computer version of the drill-and-practice game provided a more valid test of student performance in relation to the time spend on the task. Thirdly, the simulation game was shown to have elicited similar responses from the students, irrespective of the game version.

DISCUSSION

The interrelationship of three important variables (student, game and game environment) with respect to education games has been explored in this study. One of the aims of the study was to examine the effectiveness of educational computer games on student learning when compared to the non-computer version of the same educational games. In addition, consideration was given to the influence that computers may have on student responses to the games.

The results from the study must be treated cautiously; they are obviously based on a very small sample. Further, the data are more qualitative than quantitative in character. Nevertheless, the results provide some useful pointers.

Game influence

The results of this study indicate that the game environment is an influential variable on student responses, particularly if the game is strategic and/or drill-and-practice. However, for the simulation game the game environment appears to have had little effect with respect to student responses. Evidently, the response patterns that evolved out of the interrelationship among the three variables (student, game, and game environment) were largely dependent on the student variable. That is, students with high learning abilities may produce completely different sets of response patterns to students with low learning abilities (such as those chosen as participants in this study).

One of the claims investigated in this study was a claim made by Chaffin et al. (1982) concerning the effectiveness of educational computer games with video-game formats in teaching students with low learning abilities. These authors have suggested that educational computer games that have high motivational features (such as those with video-game formats) would cause students, especially those with low learning abilities, to want to learn. Although the computer games used in this study did not have video-game formats, these games were nevertheless representative of those to which students and teachers have ready access at the present time. Observation of student responses in this study tends to indicate that the crucial factor in encouraging the students to want to learn, is related to the type (strategic, simulation, or drill-and-practice) of educational game rather than the high motivational features of a computer game.

The kind of educational computer game which appear most appealing to the students (no surprisingly) was one which had the fewest written instructions and a minimal number of computer keys to handle. In addition, the content of the game software must be appropriate to the students' ability level and the content must be unrolled at a controllable speed for the students. This is in contrast with the claim by Chaffin et al. (1982) that low learning ability students would benefit and are more attracted to computer games with a high response/output rate (that is, courseware with video-game format).

In analysing the computer game-playing experiences of a group of computer players, Myers (1984) reported that being able to participate in a game provides more satisfaction for the player than being able to control the game patterns. He argued that being in control of the game patterns does not provide the same sense of cooperation between the player and the game as the participation experience (such experience requires time and effort).

In the present study, observation of student responses to the computer games supported Myers' claim. That is, the students were observed to be more motivated towards the type of computer game which permits them to react in their own time (self-paced situation).

Educational benefits of computer games

According to the literature, educational non-computer games are beneficial to student learning in a number of ways. Games encourage the learner to be actively involved in learning activities rather than passive involvement (Boocock & Schild 1968). Game playing reduces social distance and provides a more relaxed learning atmosphere as well as encouraging open and vigorous communication amongst participants (Bredemeir & Greenblat 1981). Accordingly, students can learn and benefit educationally from playing games.

With respect to computer games, Myers (1984) reported that players do learn (such as concepts and skills) from playing them, though the learning is almost always specific to the games in question and have little relevance outside the game. For example, being skilful in knocking down bricks in a computer game would have little relevance to the real-life situation. Myers (1984) argued that game knowledge is different from real-world knowledge. That is, game enjoyment results from discovering connections and patterns within the game structure and manipulating these patterns in order to establish control. To use similar strategies in real-life, however, one must consider moral and practical obstacles and these obstacles may be beyond the power of the individual to manipulate in order to gain the desired control. Although there is a distinction between game knowledge and real-world knowledge, it could be argued that some game knowledge and skills could be transferable to a real-world situation. For example, problem-solving strategies that can be developed through gaming — as in war and military games — could be transferable to real-life situations — war and military combat (Vickers 1984).

The findings of the present investigation indicated that the interrelationships among the student, the game, and the game environment are complex. The patterns of responses from the student participants appeared to be unique for each type of game and game environment.

The finds from this study tend to show that educational computer games, in particular strategic type games, elicited behaviours that are conducive to learning (e.g. attentiveness and strategic though specific to the task). Further, drill-and-practice computer games are more efficient and reliable than non-computer versions in assessing time-on-task and mastery level. With simulation games, it has been suggested that the game situation and the learning content determines whether a computer or non-computer game is more effective.

In general, educational computer games are beneficial to student learning providing that the game is appropriate to the student's ability level. With students who have low learning abilities, it was observed that they responded well to computer games which allowed them (the students) to operate the games at their own pace. This is in contrast to the claim by Chaffin et al. (1982) that students with such abilities are motivated to use educational computer games which have a high response/output rate.

IMPLICATIONS

The most valuable information to be discovered in investigations of the type in this study is not non-computer games are different from computer games but how educational or instructional games can contribute uniquely to learning.

The study has shown that within the broad classification of educational games, each sub category has unique properties and elements. Also, each of these sub categories are designed for specific education purposes. For example, drill-and-practice games are designed to enhance and reinforce previously learnt knowledge and skills. Simulations are designed to allow the student to assume a new identity and experiment with different kinds of behaviour and situations.

However, many educators and students for that matter would not be aware of such classifications. The authors believe that many classroom teachers are not utilising games to supplement or complement their teaching strategies because teachers are not aware of (that is, do not appreciate) the different types of learnings that a student can gain from playing the various types of educational games. Perhaps much of this lack of appreciation of games by class teachers is related to the way educational games have been presented in the literature. The authors have noted that often educational games are portrayed as either a general classification of games that are less popular to game players (Myers 1984) or they are classed as simulation games that teach, for example social awareness, empathy, and cooperative effort (Boocock & Schild 1968). Such a portrayal of educational games which is contrary to what they are meant to be.

With students who have low learning abilities, it was observed that they responded well to computer games which allowed them (the students) to operate the games at their own pace.

A useful avenue for future research would be an exploration of the various sub-categories of educational games and an examination of their structure in relation to their effectiveness for classroom purposes and their adaptability for computer implementation. Hence, appropriate types of educational/instructional

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RIGHT BRAIN THINKERS ATTACK COMPUTERS

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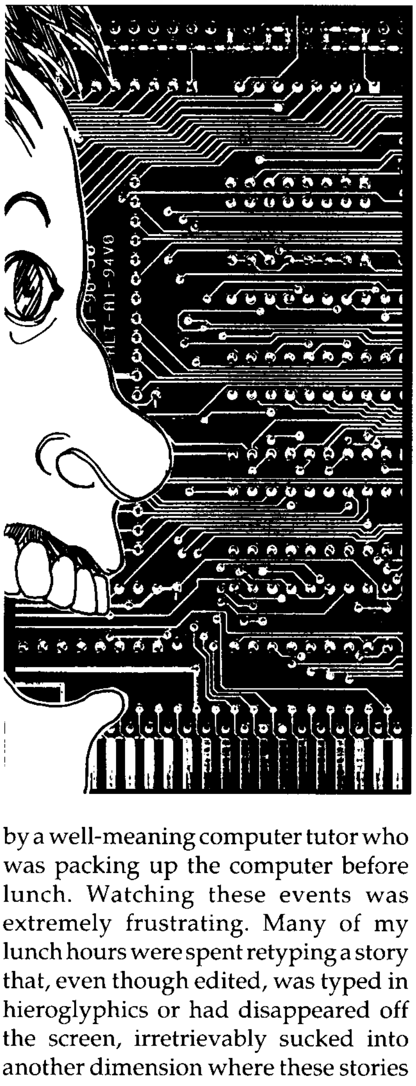
When I was first approached to write this paper I wondered 'What is "right-brain learning" and what have I been doing with computers to cater for students who have this preferred learning style?' I scoured through many education journals and found that there were very few recent research articles on right brain learning styles but an abundance of articles on left brain learning styles. After reading through a handful of articles I had found, I began to realise that this issue of preferred learning styles was quite complex (e.g. a student can have a different preferred learning style in each subject area and not just one over all subject areas).

I began to take a closer look at why some of my students were succeeding in one subject area and not others. After observing my students closely, I created an individualised check list for each student covering the types of activities, groupings, equipment used and his or her strengths and weaknesses. Through this activity I gained an understanding of why some of my computer activities were more successful than others.

One such computer activity that was extremely successful was the utilisation of computer drawing programs to illustrate students' stories as demonstrated by Phil Callen at the 1990 World Conference for Computers in Education. At the time this approach to using computers in the classroom was quite revolutionary to me as until now I had been struggling with word processors and computer graphic packages to produce and illustrate students' stories.



Like many teachers at the time, while originally enthused by the idea of using word processors to publish children's writing, I soon found this activity both time consuming and an inefficient use of computers. Watching my 8- and 9-year-old students struggle with the typing; one fingered and four words a minute; collapsing exhausted at the end of a mammoth typing session; only to find many errors or to have the story wiped before it had been saved, by a well-meaning computer tutor who was packing up the computer before lunch. Watching these events was extremely frustrating. Many of my lunch hours were spent retyping a story that, even though edited, was typed in hieroglyphics or had disappeared off the screen, irretrievably sucked into another dimension where these stories float around aimlessly.

From the outset, the opportunity for students to create cartoons for television motivated students to proceed with the process, even those who had produced very little in the narrative genre. It gave students the opportunity to produce detailed and complex stories, and allowed students to choose the process with which they felt most confident. The complexity of their stories was not limited by their writing skills.

The narrative genre was modelled extensively over two terms and the students had gained a good working knowledge of its overall structure (i.e. orientation, complication, resolution). I produced two proformas for mapping out their stories, one which utilised the right-brain thinking skills of drawing, summarising and identifying main ideas to map out their stories in a series of three to six pictures and listed the main ideas presented in each picture. The main ideas were then used to form paragraphs and the students wrote a script to accompany their pictures. The other proforma emphasised the left-brain thinking skills of writing, outlining and analysing stories. The students were required to write the story first and identify the narrative components in their story and then illustrate their writing in a series of three to six pictures. Although the task was the same, that is, to write a story, they chose their own path to achieve it.

The students were asked to work in groups of two or three to produce their stories. The dialogue, problem solving and cooperation skills that evolved out of this process was most productive and task commitment was high. Every student felt confident about his or her role in producing his or her cartoon.

When they had mapped out their story pictorially and written their script to accompany the pictures they were ready to go to the computers and commence drawing their picture slides. In preparation, they had spent one term 'playing' with the program *Deluxe Paint III* acquainting themselves with the various tools, saving and loading processes they would use.

Each group was given a data disk and a computer time slot during the day. I found that it assisted the students with continuity when they were given a block of time (e.g. from recess to lunch). We found we could successfully manage four groups of students with a block of computer time during the school day. The computer 'ran hot all day'.

The groups also had a 'log'. They went to the computer with recording the role each member played (e.g. computer artist, encourager [or backseat driver], date, time spent on the computer and the pictures they had completed). Each group member had to rotate his or her role every time he or she went to the computer so as to have opportunities to develop skills in each role.

When they had completed their series of picture slides, to illustrate their stories and created a title and credit slide, they were sent off with a tape recorder to record their script on tape. Some of the sound effects they recorded were highly creative.

The next stage of timing the picture slides to coincide with the tape-recording was too difficult for the 8- and 9-year-olds but Year 6 students coped well with the task. We used the program *TV Show* to create a computer slide show from the drawings we had created on *DeluxePaint III*. The computer and tape-recorder were plugged into the Video and Audio in connections on the back of the video recorder, played simultaneously and videotaped.

The students had a television showing of their cartoon 'in-class' and discussed and shared techniques they had used to produce pictures and sound effects with each other. But the highlight of the whole procedure was when we had a 'showing' of our cartoons to Year 1 who gave the students the best feedback of all as they laughed and clapped with delight at their cartoons.

The 'cartooning' process of story production provided all students regardless of preferred learning style an opportunity to create a narrative and also develop skills in the non-preferred learning style that would assist them to utilise both brain hemispheres.

The 'worth' or success of this computer activity was not just the superb stories they created but the increased self-esteem each child displayed. They all had a sense of 'I can do this. I want to do this.' During the whole term we worked on the cartoons, not one child grumbled about the numerous writing tasks, catching up on missed work in other subject areas or the hard work involved. My greatest difficulty in classroom management was getting them to turn off the computer and go out to lunch or go home. It was a most rewarding experience for all concerned, me especially.

The next term, we used what we had learnt from the cartooning process to create a documentary, *All about Frogs*, incorporating the report, explanation, procedure and narrative genres. Although the computer picture slides and scripts were completed, I did not see the video completed as I left the school for warmer waters on the North Coast. ❖

NOT "JUST" ART:

computer paint programs and ideas processing

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The recently published National Curriculum for Technology lists 'Designing, Making and Appraising' as one the strands which will provide an integral framework for units of work involving technology. Computer paint programs provide a design medium which integrates well with all aspects of the curriculum. Design is important in that it combines functionally with the aesthetic, thus challenging art, science and every aspect of human pursuit. This paper will outline some of the ways paint programs can be used in the classroom so that children's learning is enhanced, and will make reference to the ways paint programs provide the ideal medium for Designing, Making and Appraising.

THE CLASSROOM: WHY USE A PAINT PROGRAM?

We live in a visual world, in many ways we store information as visual images. In terms of the classroom, a paint program can be used as a cross-curricular tool for visual information. Incorporate text and sound and the images can be regarded as true classroom multimedia. For the average classroom teacher, a little expertise in managing class projects involving 'paint publishing' is easier to handle than many other classroom computer applications. Paint programs can be incorporated meaningfully into any learning situation and any year level, and unlike applications such as word processing, paint programs can be more easily managed in the classroom environment given the current level of computer resources in most classrooms, that is one computer per thirty children.

Children working in groups can cooperatively produce a piece of work using a paint program in a relatively short period of time. Paint programs provide a resource where children can explore design and aesthetics in a totally new way. Children who claim they 'can't draw a straight line' no longer need to — the straight line tool does this for them. In fact the work produced on the computer by the child who usually rubs his or her way right through the paper looks just as good as the artistically 'gifted' child. As the work produced by each child at the computer possesses the same qualities and integrity — the emphasis changes from product to process; the place where teaching and learning actually occurs. Children can access every two-dimensional shape, perspective, colour, movement, and gain the freedom to experiment and make mistakes without having to re-create

continued over

designs with the tedium characterised by the traditional media such as paper and pencil.

Projects can be published on screen, videotape, printed on overhead transparency or paper. Images can be drawn, reused, scanned or digitised, modified and manipulated in countless ways. Paint programs provide an accessible and affordable form of multimedia. Created images can be enhanced through the use of presentation software, audio recordings and digital samples and the like.

NOT ONLY ART BUT A CROSS-CURRICULAR PUBLISHING TOOL

'The multimedia environment offers a number of new learning experiences for students including the ability to trace the learning path, as a brainstorming tool to aid creative process, and the use of more senses to reinforce the learning process.' (Fieldon 1990, p. 63)

The process of classroom computer based ideas processing incorporate the notions offered by Piaget, Bruner and others where children construct their own knowledge. Students undergo *confrontation* where they are presented with a stage relevant task during a classroom brainstorming session or group activity, *Inquiry* where the students experiment and manipulate the data (in this case images) or research and report information relating to a topic and *Transfer* where the acquired knowledge is presented through the use of language, art and sound or incorporate into subsequent projects.

The fact is that many teachers aren't using paint program for art, they're actually using them to: explore maths concepts (take a look at *Concept Processing using Deluxe Paint* by Gavan Brown [n.d.], available from Commodore Business Machines); assist in, and report on science experiments; explore and publish social studies concepts; and incorporate their use into a range of language-based activities. Why is it that shadows appear blue in winter? How does the internal combustion engine work? The science of these and many other wonders can be explored in the classroom using a computer and a paint and animation program.

Computer-based paint and animation allow classrooms to create electronic story books using presentation software, as well as provide a medium for children to present visual presentations of concepts which are often difficult to publish such as gears and pulleys, colour mixing and a myriad of such like.

Many advanced paint and animation programs provide experiences in symmetry, moving objects along x, y and z axes, estimation, angles, tessellations and a host of maths concepts. They allow images to be manipulated in a variety of ways (stretched; flipped; copied) so that creativity and ingenuity are encouraged.

Use of a paint program in the classroom provides two advantages I feel are important. The educational experiences involving the software are firstly; learner-centred and secondly; teacher-guided. The value in the activities involving the computer depends on the teacher managing the project or learning experience. Therefore the teacher is in total control and takes responsibility for the classroom learning experiences. The activity is also learner-centred due to the fact that the learner is participating in an active role, and participates according to his or her current level of performance. The program I like to use in the classroom is *Deluxe Paint IV* for the Amiga computer. This program is simple enough to be easily used by preschool children as well as providing high-end facilities suitable for trained adult professionals employed in advertising, art, video and television. In fact many of the graphics seen on television and video were created with 'Deluxe Paint' and the Amiga.

> ***'The multimedia environment offers a number of new learning experiences for students including the ability to trace the learning path, as a brainstorming tool to aid creative process, and the use of more senses to reinforce the learning process.' (Fieldon 1990, p. 63)***

FIRST THE COMPUTER THAN THE REAL WORLD

The computer provides the flexibility for children to design and redesign, so that when materials are selected for construction — whether they be clay for pottery, balsa wood, cardboard, leather or any other material, the design is well understood. Advanced paint and animation programs provide the classroom with an effective design tool, as effective as the manufacturing industry has found in CAD packages.

PRAISING THE APPRAISING

One of the outstanding features of children designing on computer is their willingness to evaluate and redesign concepts. Due to the flexibility of the technology, children openly critique design features; adding, subtracting, changing, knowing that previous designs can be redeemed from disk. The technology provides a framework for new levels of experimentation and risk taking made prohibitive by traditional materials. Children can take a previous design and enhance it without ever interfering with the original—a freedom never experienced when using traditional materials. This freedom provides the classroom environment a medium where learners have the facility to cooperatively critique, experiment and re-create.

Paint programs provide a valuable resource for the classroom, a tool for the learner to publish ideas, and a tool for the teacher to design and provide challenging and rewarding learning experiences for the classroom student.

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Computers in the ART ROOM

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I remember vividly watching a video on computer graphics which was utilised for advertising about seven years ago, and feeling the surge of excitement run through my veins, and the desire to want to know all, now. It wasn't until I had completed my first course in computer graphics at the Hawthorn Institute in Victoria, that I realised that it was impossible for me or my students to achieve such fantastic results, because the cost of computers used by the artists was prohibitive. Undaunted, and still determined to find a suitable program, I blundered my way through a few more courses, until the little 'Mac' face smiled sweetly at me, and I smiled back. I was at last recognising the programs and my brain and hands were coordinating. My beginnings as a student of computer graphics has remained with me as a teacher, because I can truly relate to the frustrations of my students, and restrain them from throwing the mouse out the window. The imaginative prowess. The 'Mac' I find is particularly user-friendly, and is suitable for a variety of courses across the curriculum, and hence is also budget-friendly. I find the use of windows very easy, rather than trying to remember which key to strike to access various aspects of different programs on the 'DOS' machines, hence I love the 'Macs'.

The programs in graphics are suitable for a wide range of age groups, ranging from 2-year-olds to top class graphic artists. At Annesley College, the school where I teach, students mainly use a variety of graphic drawing programs. These are presented to the students as a means to achieve a higher standard in graphic skills rather than pencil rendering, and in many cases repetitive design drawing. The computer is used as another drawing tool; just as one would change from a pencil to charcoal, or paint brush, the 'Mac' allows for another form of expression. It is another means to an end. Students are still expected to display drawing skills and an understanding of the features of design and composition. The print-out is not necessarily the finished product. In many cases it is the beginnings of the main project. Designs can be used for fabric printing using the newly developed Riso screen printing method. This method involves using a carbon-based printout from either a laser printer or a photocopier, and then running the print and Riso paper through a Riso Screenfax which 'burns' out the line work and produces a stencil ready for screen printing. Other designs can be used as cut stencils for T-shirts, or as tracings for silk paintings. The possibilities are endless. Lettering programs allow students to reproduce graphic communication designs of a very high quality, without jeopardising creativity. I bet many art teachers reading this have often thought that many students' work has been spoilt through poor quality lettering. Not any more! By photocopying onto a clear transparency, lettering can be created in a multitude of formats and fonts, and simply laid over the top of the design, which has either been created on the computer or drawn freehand using traditional rendering methods.

Freehand drawings or photographs can also be included in the art work using a scanner, and integrated with the lettering. Depending on the standard and level of the students, the scanner also has a wide variety of uses. One project which the students really enjoy is to scan in a photograph of themselves, and manipulate the image on the screen, using a draw program. The image can be distorted, or moustaches etc. drawn on. The lettering is then added to create either a humorous 'wanted' poster or a fictitious personalised business card. There is such a wide scope for creativity, and the students learn to combine a variety of techniques into an enjoyable activity. Another exercise using scanned photographs was to print out a series of one face using a variety of tonal qualities that occurred. The results were outstanding and the students gained considerably in self-confidence in portrait painting.

The more senior students, who have been using the programs for longer periods are beginning to use the computer with flair and creativity. One student in particular wanted to create a painterly technique, without the product appearing 'too computerised'. The scanner came to the rescue. The first experiment was to scan in a piece of Glad Wrap. The result was fascinating. The tonal qualities and dot sizes were modified, and various print-outs were photocopied onto production transparencies. These were then set into consecutive overlay positions to give a 3-dimensional effect. The next step was to do this in colour. The experiments continued using glue on plastic, powder stuck onto glass, thick impasto applied with the fingers etc. The print outs were really exciting, and the final product was a combination of the laser printer, photocopier and photographic silk screen. The computer is not restrictive. It can be a wonderful beginning to a whole new world in creative technology.

Another exciting technological facility which enhanced the print-out was to use a Canon Colour Laser Copier. On a recent excursion to the Victorian Arts Centre, we were fortunate to meet Bashir Baraki, an artist who has spent considerable time researching the artistic use of CLC. His intention was to explore the possibilities of an inter-marriage between traditional means of expression and technology. This search for the new provided Baraki with an exciting new concept in laser art work, which we eagerly grasped at to provide a new means of expression to the computer print-out.

Computer graphics can be as restrictive as one desires or as wildly creative as Jackson Pollock. The colour printers have a wonderful resolution and the finish is of an extremely high quality. I guarantee that your students will be ecstatic with their results. Don't forget also that photocopiers can repeat and enlarge colour prints to give poster size products.

After many years of using the Macintosh, I am still learning. Every time I think I am getting somewhere, a new product hits the market, which is more exciting than the last. This is why computer graphics is such an exciting area in which to be involved, and I would highly recommend it to any art teacher looking for a new lease in life. If I can be of any assistance I would be more than happy to help. ❖

SO IS IT JUST SOCIAL STUDIES?

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Databases in the primary classroom

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Software developers have flooded the market with educational databases from convicts and bushrangers to footballers and politicians but what is their real potential in the primary classroom?

This paper attempts to outline a rationale for the use of databases in the primary classroom. Topics discussed include the integrated curriculum, establishing an authentic purpose, a sequence for introducing databases for the first time and the type of learning environment that teachers can create with database activity.

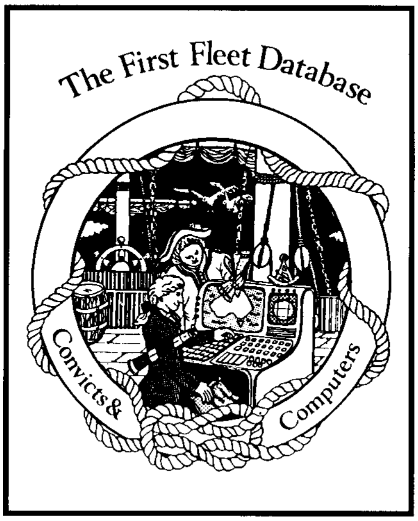
INTRODUCTION

One of the first steps for teachers considering the use of databases in the classroom is to locate a place in the curriculum for the potential use of a particular database. This involves the investigation of how the school's curriculum is organised.

A school's curriculum can be organised in a number of different ways. A traditional organisation would divide the curriculum into subjects. In a subject-based curriculum there may be potential for database use in social studies, science, reading and perhaps even mathematics.

Some schools use a thematic approach. A theme such as 'Footy Fever' could exploit *Footyworks, First Fleet, Explorers* and *Explorers Journals* could be used for a theme on 'Australian Discovery and Exploration'; a *Solar System* database would lend itself nicely to a 'Space' theme; and *Endangered Species* may work well with 'Animals'.

A far more innovative and dynamic way of organising the curriculum is to use an integrated curriculum. The integrated curriculum, as detailed in *Learning Through an Integrated Curriculum: Approaches and Guidelines,* (Minister for Education, Vic. 1985), is divided into topics. Each topic becomes the basis for a classroom investigation or inquiry. Advocates of this method believe the children should have a considerable say in the selection of the topic, the focus of the investigation and in determining some, if not all, of the classroom activities. This, plus a process of brainstorming and question formation (focus and contributing questions) is designed to develop an authentic purpose for the classroom investigation and allows the children to feel they have some control over the investigation and the direction it will take.



These two concepts — ownership and authentic purpose — are very powerful ideas and are central to the workings of the integrated curriculum. Establishing both in the classroom is a difficult and challenging task, but the rewards can be great. Supporters of the integrated curriculum believe that once ownership and authentic purpose have been established teachers can expect an increase in motivation and interest, an improved student attitude, behaviour and classroom control will become less of a chore, a rekindling of curiosity will occur, there will be a return to the natural desire to learn that schooling so often seems to extinguish, and a rich, powerful learning environment will be established. (Minister for Education, Vic 1985)

Also central to the integrated curriculum is the blurring of lines between subject areas. Instead of dividing the classroom activities into subjects, the teacher divides them into three types. Firstly, *central activities,* which are directly related to the topic under investigation and have a creative problem solving focus. Secondly, *related activities,* which relate to the topic and the central activity and pertain to all areas of the curriculum catering for a range of abilities and interests. Finally, *revision and consolidation activities,* which are not strictly related to the topic but concentrate on specific skills and are more subject based.

In selecting activities the teacher tries to place the students in a whole language environment where they are continually challenged to use, for productive ends, the four modes of language — reading, writing, speaking and listening. The teacher designs the activities so cognitive and affective learning processes can be developed (Ministry of Education, Vic. 1985). The assumption is made that all learning is underpinned by language and that children acquire language by using it

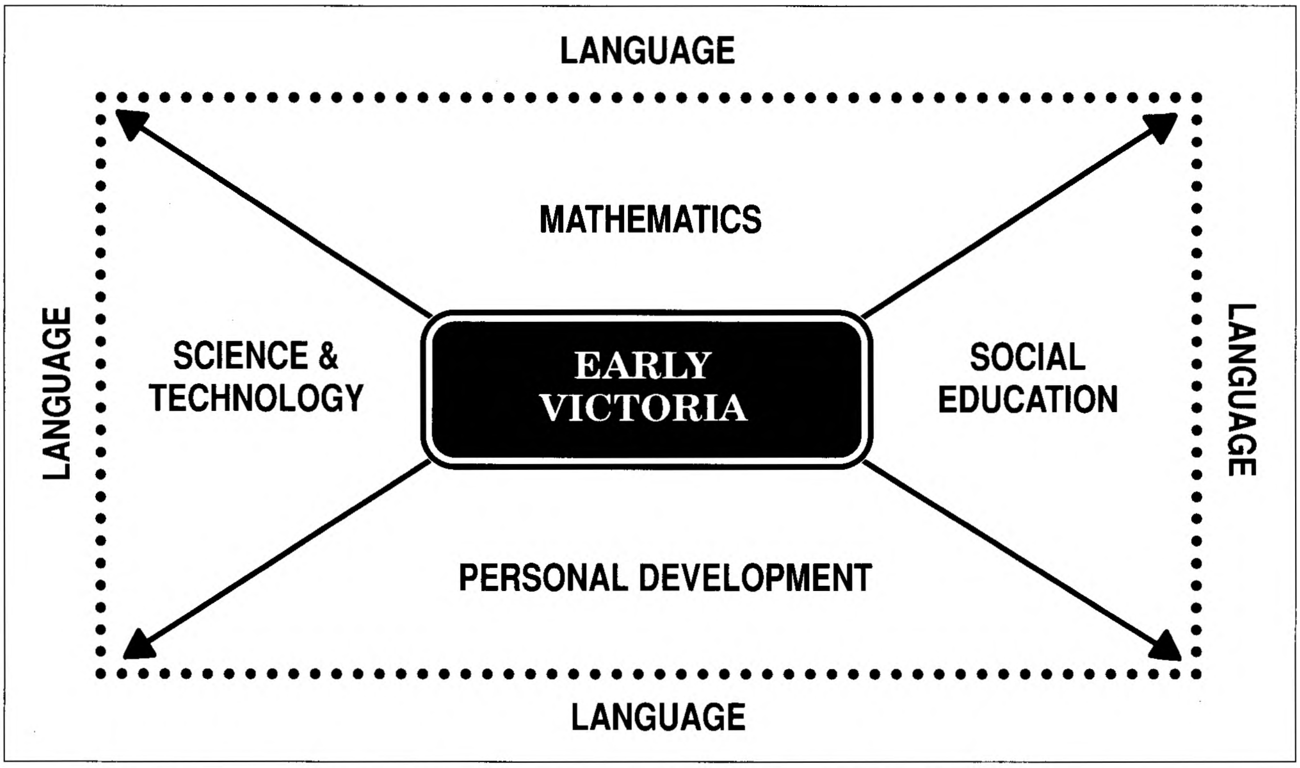


Figure 1 *An attempt to demonstrate diagrammatically the curriculum considerations of the integrated curriculum.*

for an authentic purpose. The rationale behind each topic can be represented diagrammatically. Figure 1 is an attempt to illustrate the curriculum considerations behind an integrated curriculum topic.

Some schools such as Mossgiel Park Primary School have refined the integrated curriculum process and use a curriculum plan called the 'Integrated Curriculum Matrix' (see figure 2). The themes — 'Power and Control', 'Relationships', 'Environment', 'Communication and Media', 'Technology and Lifestyles' come directly from the 'Social Education Framework'. Across the top of the matrix consideration is given to the maturation level of the children so the topic is at a level at which the child can cope. The topics, which are written in each cell of the matrix, are chosen with input from the children, staff and parents. The topics are designed to convey the broad understandings and issues of each theme in a rational and logical sequence and to ensure a body of knowledge, skills, attitudes and concepts can be built up from P–6 (Ministry of Education, Vic. 1987). The integrated curriculum matrix grew from an action research project carried out at the school in 1991 (Romeo 1991). The matrix is experimental and, at the time of writing, had not been fully implemented.

Taking an example from the matrix — the investigation of 'Early Victoria' (Grade 4 Lifestyles/The Area in Which I Live), the children and teacher may have established the following series of focus questions.

- **Week 1** 'Who discovered Victoria and where did the people who live here come from?'
- **Week 2** 'What was it like to live in Victoria last century?'
- **Week 3** 'Why was the discovery of gold so important to Victoria?'
- **Week 4** 'Why were there bushrangers in early Victoria and how did they operate?'
- **Week 5** 'What were some of Victoria's early industries and how did they operate?'
- **Week 6** 'Who explored Victoria and why?'

This opens the way for a number of software programs to be used in context but especially *The Bushrangers' Database* and *The Explorers' Database.*

Associated with each focus question may be many contributing questions. In week 3, for example, the children may want to know: 'Who was the youngest bushranger?' 'Who was the oldest?' 'How did they die?' 'Who was the most notorious?' 'What crimes did they commit?' and, so on. Ownership can be enhanced if you display the focus and contributing questions in the room and list the children's names next to the questions they contributed. (Be sure every child is involved and has his or her name on the list at least once).

You have now located a place for the potential use of two databases. Both databases are excellent tools for helping the children with their investigation of this topic and will go along way to answering the focus and contributing questions. They can also be used to create related activities and for extension work. It is important to remember however that the software is an aid to the investigation along with numerous other resources. It is important to not let the software be the only resource driving the curriculum.

Of course when children are confronted with a database for the very first time they are going to need to be taught the basic skills of using it and be given some understanding of how it will aid their investigation. What is required here is some forward planning. Things will come unstuck if you arrive on Monday morning and decide to do 'Bushrangers' at nine o'clock. Below is a suggested sequence for introducing databases.

(I have used *The Bushrangers' Database* as an example but the sequence could apply to other databases. The

	Me/Myself PREP	Others and Me ONE	My Neighbourhood TWO	How other people live THREE	The Area in which I Live FOUR	My Country Australia FIVE	The World in which I Live SIX
Power and Control	Step into My Shoes	Decision Makers	Rights, Rules and Responsibilities	Working Together Occupations	Famous Australians	The Aborigines	Government
Relationships	Family Portraits	Sharing and Caring	Celebrations	My Home My School My Community	My City	I'm an Aussie	Other Countries Other Cultures
Environment	Our Surroundings	The Weather	Water	Australian Animals	The Sea	A Harsh Land Natural Resources	Our World
Communication and Media	Sending Messages	Communication	Newspapers	The News	The Media	Myths and Legends	Advertising
Technology	Toys and Tools	On the Road	Travel in Australia	Our Changing Technology	The Computer Revolution	Energy	Space The Final Frontier
Lifestyles	Healthy Me	Healthy Eating	Rural and City Links	Childhood Now and Then	Early Victoria	Australian Discovery and Exploration	World Exploration

Figure 2 *The integrated curriculum matrix developed at Mossgiel Park Primary School in Victoria as part of an action research project in 1991.*

suggested sequence relies heavily on the work presented by Susan Bell and Ian Scott in *Springboards: Ideas for Using Computers in the Classroom* (1985).

A SUGGESTED SEQUENCE FOR INTRODUCING DATABASES

There are some prerequisites that teachers should observe before using the database in the classroom. Firstly, familiarity; make sure you are familiar with databases in general and the particular database you wish to use. Know its potential, its limitations and what it is capable of giving you. You may be able to get away with not knowing some software packages intimately, not so databases.

Secondly, confidence; in order to successfully introduce databases you must feel confident about the concept of databases, their potential use and be happy with the prospect of using them in the classroom.

Finally, aims and objectives; you must have it clear in your mind why you are using the database in the classroom. Yes it will help you with your investigation but later on I hope to show you that database activity is more than just presenting information.

PRELIMINARY WORK

In my example you know that you will need *The Bushrangers' Database* in week 3. So you need to start well before week 3. A good place to start is to introduce the concept of a database before you introduce a particular database package. Use your creativity plus work sheets from various databases packages to introduce the children to the concept of databases in general and how they can help with the investigation of topics. Perhaps some work with a less sophisticated package such as 'First Fleet' may be desirable.

INTRODUCING *BUSHRANGERS* FOR THE FIRST TIME

Assuming you have done the preliminary work the first place to start is to introduce the children to the database by showing them a printout of some of the data, say the records of a few bushrangers. It can then be examined, the material can be discussed and the children can get an idea of the field names and the type of information each field contains. A further printout could be shown of calculator data. An analysis showing the age of bushrangers when they began their career would lead to discussion and stimulate interest as well as demonstrating another function of the database (i.e. the Calculator).

The next step would be to get the children to do some simple searches using various printouts. Perhaps a worksheet could be created by the teacher to help. It is important at this stage to keep it relatively simple. For example, using the printout showing 'Age Bushranging Began' (e.g. from above) children could be asked to find out: 'How many bushrangers were younger than 20 when they started bushranging? or, How many were older than 50? and so on.'

Using printout material again, say the individual files of six bushrangers, you can increase the complexity of the searches. Start with two fields with questions such as: 'How old was the youngest bushranger and what was his name?' How many had black hair and blue eyes?' 'How many bushrangers were born in England and operated in Victoria?'; and, so on.

Depending on the ability of the children you may then move them onto even more complicated searches: 'Were any of the bushrangers under 20 convicted of murder and executed?'

If the children have not had much experience with databases then go slowly and structure the experience so it is a pleasant one and most importantly a successful one!

So far the children have not touched the computer, it has all been 'hands-off' work. When you think the children are ready you can introduce the database on the computer. You could do this by asking them to check some of the answers to the 'hands-off' work. Now is the time to introduce them to some of the basic workings of the package.

Again moving slowly provide worksheets of gradually increasing difficulty making sure the children have plenty of time to explore on their own. Structure the worksheets and activities to reflect the questions the children will eventually be asking.

As their confidence grows you can get the children to retrieve data for an authentic purpose. This is the stage where they can start to answer some of their contributing questions — Who? What? When? Where? Of course, after using the database the children will probably have many more questions they want answered. These can be added to the chart on the wall at any time.

The final stage is to encourage the children to look at the database as more than just a collection of facts about bushrangers. The information can be analysed and interpreted in a variety of ways leading to a number of different conclusions. At this stage of understanding the children can begin to answer their focus questions — Why? How? (Bell & Scott 1986).

The introductory work will be time consuming and frustrating. You will need to be aware of individual differences and it may be that some children or even the whole class will not get to the level of understanding that is required for the latter stages. But the groundwork you do will be the foundation that future teachers can build on and you are not relying solely on the package to answer all your questions, it is just one resource among many.

Some forward planning will be necessary and so will some experimentation. Learning is a risk taking adventure not only for the children but for the teacher as well. Don't be frightened to experiment and develop your own sequence of lessons that suits your own group of children.

SO IS IT JUST SOCIAL STUDIES?

The connection between databases and social studies and science has been well documented and well supported by software developers (e.g. Sunburst, Knoware, Dataworks). Many authors have acclaimed the virtues of databases for inquiry learning, for hypothesis testing and for information gathering (Kerr 1986; Education Department of South Australia 1986; Hancock 1989; Bell & Scott 1985; Wills et al. 1986); software developers have produced an array of database management systems and data files to match. There seems to be little doubt that databases have much to offer the social studies and science environments but there is much more to it than that.

Thinking of the activities that the children will be involved in while working on databases as just social studies, or just science, is a very narrow view. When you introduce database activities you are creating a learning environment where a number of very desirable learning processes are at work.

If you have the children using the database in small cooperative learning groups you give them the opportunity to share information, listen critically, to question, argue, persuade, and so on — they must read, listen, talk and write — all for an authentic purpose — to get information that will help to answer their focus and contributing questions. Database activities in small groups places the children in a whole language environment. They use the four modes of language for productive ends.

Mastering all aspects of language is a thinking process. It is imperative to teach children to think. They cannot learn to read successfully if they are not taught to think about and interpret what they have read or what someone has said, or what a classmate has written. A successful learning environment will challenge children intellectually. Database work is an intellectual challenge. By using databases in your classroom you can provide opportunities for children to exercise a number of important cognitive processes such as: observing, questioning, hypothesising, generalising, reflecting, inferring, predicting, analysing, synthesising, problem solving, planning, decision making and so on.

Developing thinking skills is so important yet is overlooked by many teachers. The database environment is an excellent avenue through which the cognitive domain can be brought back onto the agenda.

A successful learning environment fosters certain personal qualities such as: open-mindedness, creativity, persistence and determination, curiosity, cooperation, independence, self-esteem, group discussion, self-control, risk taking and so on. Children will not develop these personal qualities if they are not put into situations where they are necessary to achieve the desired goal. 'If we don't all cooperate we won't be able to get the information we need.'

They must be given the opportunity to strive, persist and succeed and to experience how cooperation can achieve the group's goal. As the teacher you must encourage these personal qualities and reward children for displaying them. Rewards do not always have to be stickers, sweets or bookmarks. The best rewards are intrinsic — the joy of striving for and reaching your goal; the sense of pride in a job well done; genuine praise from people who care.

Cooperative groups working on the computer can be an excellent environment for fostering and developing these personal qualities.

Not well documented is the connection between mathematics and databases. As your familiarity and confidence grows you will begin to understand the mathematics of database systems. Many teachers struggle to integrate mathematics into other areas of the curriculum; to develop authenticity and relevancy. The database environment is loaded with mathematical concepts: graphs, pattern and order, equality and inequality, percentages, logic, problem solving, sequencing, order of operations, visual representation, statistics and so on. It provides many opportunities for the creative teacher to demonstrate how the skills of mathematics can be relevant to an investigation.

An added advantage of using databases in the primary classroom is that you are introducing children to a software application that has widespread use in the business world and the community at large. You are enhancing their computer literacy and awareness. By using the computer as a tool to aid their investigation the children see the machine in its correct context and they receive practical computer experience as part of their normal teaching–learning experience. (Newhouse & Oliver 1990)

Learning is a natural process. Children are naturally curious and inquisitive; it is human nature to want to know. As teachers you need to capture that curiosity and use it to your and the children's advantage. A powerful way of doing so is to organise the curriculum so it is integrated and to introduce database work to your students as a tool in aiding their investigations. Using databases in your classroom in this way is a legitimate and rewarding educational process.

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SOFTWARE

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KnoWare, *The Bushrangers' Database*
KnoWare, *The Explorers' Database*
KnoWare, *The Explorers Journals*

NSW Education Department, 'First Fleet' in *Resource Materials for the First Fleet Convict Database.*

Sunburst Communications, *The Endangered Species Database*
Sunburst Communications, *Solar System Database* ❖

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who enjoy carefully sequenced and finite ways of learning. The in-built flexibility of the program allows other students to explore their own ideas laterally and use the task sheets as a spring board for their own creativity, demonstrating the power of this media to be a wonderful tool for whole-brain learning. The left-brain assimilation of the technical and sequential processes is a necessary part of the creative process leaving the right brain free to fly with ideas once there is technical automaticity.

Howard Gardner (1983) proposes what we see as 'intelligence' in mathematics is seen in the artist as a 'gift or talent', one of our other forms of intelligence. He maintains that we are truly complex beings made up of multiple intelligences and those of the arts are some of these intelligences. In that case there is a talent in all of us and it is the role of the teacher to find a road that each student can journey down to explore and mobilise his or her creativity.

Image generating computers and their associated technology are a truly open-ended tool for every student's journey to creativity and whole-brain learning.

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computer and non-computer games can then be designed to meet teacher and student expectations and requirements. According to Myers (1984), the best computer game designers are the best artists, those who examine broadly whatever is learned from games played in their natural environment and apply the same general qualities to computer games. Similarly the same general qualities should apply for non–computer games. These qualities should include how to feel or empathise, how to understand, and not in the strictest sense, how to know.

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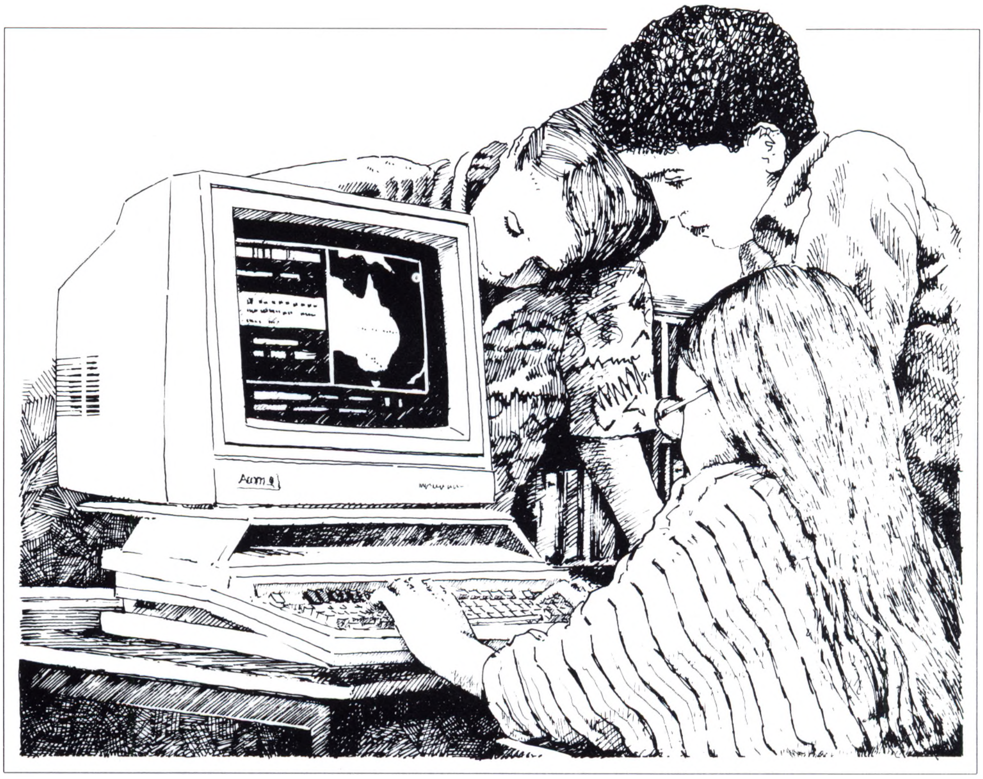

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